# Indian Industries

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The Editor is pleased to consider contributions of interest to the Indian Industry.

Articles should be accompanied by photographs wherever possible and a stamped addressed envelope should be enclosed for return in the event of unsuitability.

Trade notes and short news paragraphs are always welcome.

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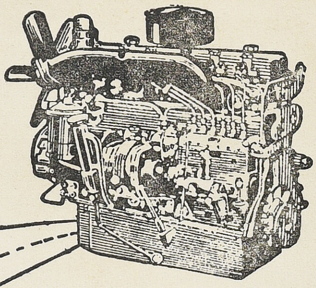

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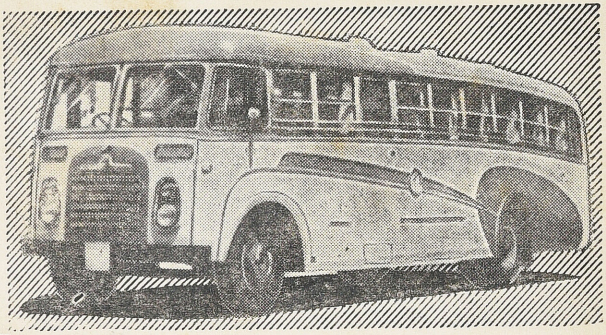

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# Flaming, Raging Enthusiasm for The Third Plan

Rightly has our beloved Prime Minister said that the flaming, raging enthusiasm for the Third Plan from the people alone will spell sure success.

" We live in an age of amazing scientific and technological change. These changes are constantly resulting in the transformation of society and the way people live. We have to undertake and take advantage of these technological transformations that are taking place. Indeed, we have to enter into the spirit of science and technology, but, ever, as we do so, we should not forget the human, the moral and spiritual values that make life worthwhile." These magical words of our Nehru will silence into oblivion the slings and arrows of the critics who in season and out of season point their finger of scorn at the pitfalls that industrial progress comes across every now and then. Very recently the American Ambassador in India Prof. Galbraith voiced forth the feeling that India has reached the stage when she will have to import technology, rather than technicians.

The first ten years of Planning in India is an experiment unparallelled in the economic history of the world. We started from scratch. Finance was an enigma, people pathetically illeterate, technical knowhow a novelty and entrepreneurial class a rarity. As Professor Harold A. Tennis of Toronto talked in plainer terms there was the problem of horizons for entrepreneurs, Governments, perhaps civilizations. And greater still was the problem of historical depth in economics. In the initial stages, under development, backwardness, capital deficiency, foreign trade orientation presented unsurmountable obstacles. We needed Eisenhowers of industries, not Napoleans. Men of vision entered the field with profit-maximization in the background and productivity increases as their ideal. Discovery of mineral resources, rising investment of capital and a socialistic approval of money-making resulted in a merging of micro and macro-economics. Our low-pressure economy did register high price-levels, thus generating an illusory welfareness.

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Can India be the workshop of Asia? Several countries aspire to be the industrial hub of Asia, And India has greater claims in the long run. Give us the tools, we will finish the job: cried Churchill in the gravest moment of British crisis that spelt political extinction. The tools were given. As one man the Britishers rose and triumphed. We in India—after an industrial slumber lasting several centuries—have rushed into the industrial arena of the world with physical vigour and hard work in our bones. The labour force today is technology-conscious. The Engineering colleges' output of engineers is staggering. Our plants and factory equipments—thanks to the noble-mindedness of foreign collaborators—are more modern and getting more up to date. The success of our internal policies contribute to a large measure to our successful integration with the economies of neighbouring countries. The air is thick with cries of export promotion and it is a matter of pride that Shri Manubhai Shah, who is a master in feeling the pulse of other nations is made our Minister for foreign trade. Commerce is safe in a most competent hand.

With the launching of Third Plan this year, our experiment is really flabbergasting the capitals of all progressive countries. Out of Rs. 12,000 crores we need for this most dynamic experiment in history, something like one-third of this sum must come as aid from abroad. The Indian tax payer is called upon to shoulder very heavy burdens. We have no other alternative. We are making everything from razor blades or radio sets to machine tools. All the profits that accrue are ploughed back to increase the productive capacity of our factories. We are really passing the "take-off point"—the stage at which growth becomes self-generating and self-sustaining.

Our entrepreneurs are creating history. They are getting their common men do uncommon things. The goals are supplied to white-collar people in the office who today are decision-makers in their own way, whether tools, policies or attitudes. Their frustrations are removed and the satisfaction of accomplishment spurs them to newer decisions of greater magnitudes. India has acquired 'managerial enterprises'—an end of bourgeois feudalism. The major segments of Indian community want, "not a perpetual struggle, but a steady job—a job producing goods at a roughly predictable cost under roughly predictable conditions, so that the goods may be sold to the market at a roughly predictable price." The managerial ideology is in a transitional stage towards a rationale for a political rather than an acquisitive culture, towards a doctrine in which the goal is to achieve a position that confers power and prestige, rather than personal wealth. In the words of the celebrated thinker Cochran: "once the major aim is transferred from extra profits for stockholders to the welfare of the organizations, the critical step has been taken in the direction of a new social adjustmant. Planning comes to be in terms of how the organization can best adjust to general social trends so as to insure survival over many years, how it can continually raise the compensation of its employees to sustain loyalty and morale." Most memorable words that should not only echo in the hearts of business executives but stay as their sole ideal in business life.

As our revered President Rajendra Prasad says: "Industrial development in India would proceed at a quicker pace if the enthusiastic support of the people

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of the country could be won over. One of the ways this can be done is to keep the people fully informed of its progress as also the problems connected with it."

This Annual in its own humble way has tried to keep the people informed of the rapid developments of Indian Industries so far. Very eminent specialists have discussed with facts and figures the progress of various industries and the problems that face them. We are made to think of future, think of our targets we have set to achieve, and link the successes of our achievements to future endeavours.

It is the march of a great nation with greater number of people, towards the greatest goal. Our objectives are clear. The kind of society we visualise is one peopled with ideologies of human equality and opportunities for everyone to lead a good life, a society based on the principle of co-operative endeavour, not with acquisitive urge. These objectives shine in all their pristine glory, lest we stray from the path.

As our Nehruji says:

"This Five-Year Plan is not just a statistical exercise or a list of the things we have to do on land or factory or elsewhere, but it is a somewhat inadequate skeleton of the rich and warm-blooded life that we hope will come to the millions of our people, and the labour that will bring it about. For without labour nothing is achieved.

*We have not only look at the mountain tops, but also to work hard and climb up to them.*

This is a great adventure for our people and for humanity itself. Let us think of our daily work in these terms, forgetting the petty worries that surround us. Then, it becomes ennobling and inspiring, and something of the greatness of this work falls on us also and blesses us."

Krishna Srinivas

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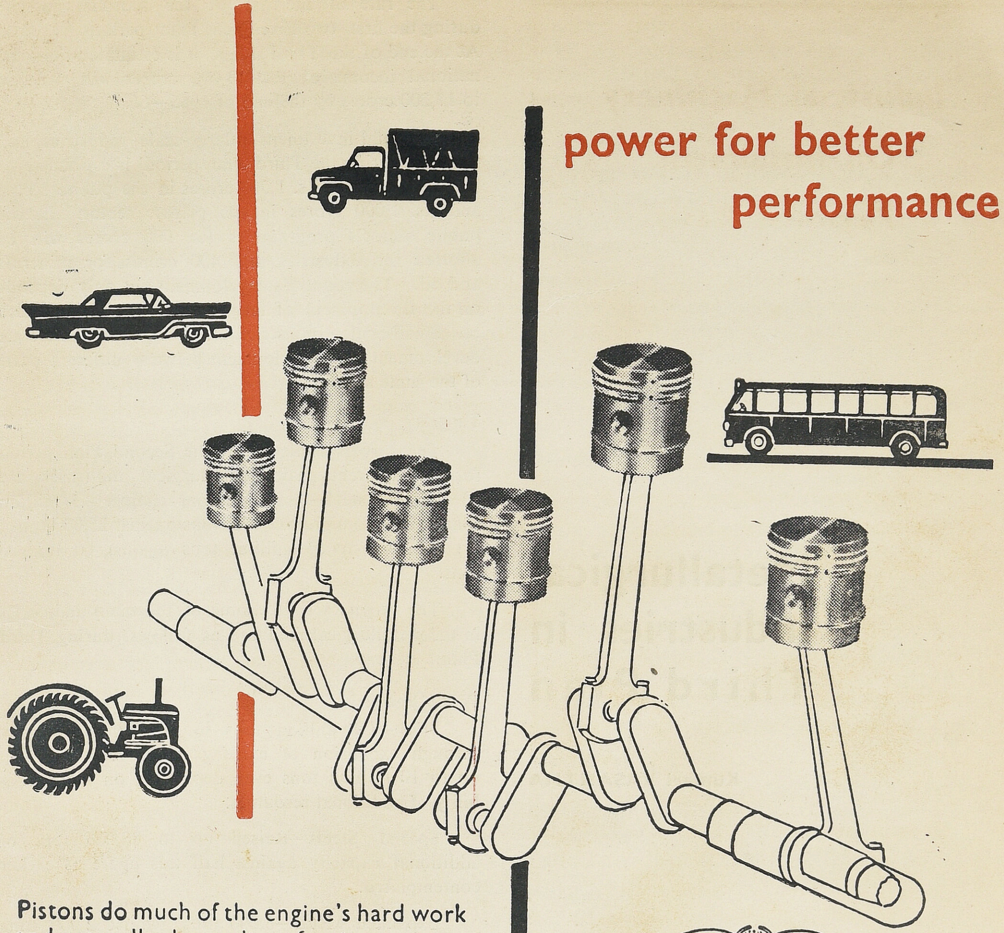

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# Metallurgical Industries in Third Plan

Kumari VASANTHA

The rate of increase of the national income during the first two Five Year Plan periods is 28%. At the end of the Third Plan, it is estimated that the national income of Rs. 13,000 crores will increase to 17,200 crores by the end of 1965—66.

The total investment in large-scale industries and minerals during the Third Plan period is estimated at Rs. 2,300 crores—Rs. 1,300 crores in the public sector and Rs. 1,000 crores in the private sector. In the public sector's programmes Rs. 900 crores will be allotted for industries and 400 crores for minerals and oil. The country's development not only depends on the development of large-scale industries but also on Small-Scale Industries. But it needs interstate development and development between different parts of the same state.

**Targets**

The targets achieved at the Second Plan period for the different main metallurgical industries are (i) finished steel—3 million tons against 4.3 million tons ; (2) aluminium18,000 tons against 25,000 tons ; (3) coal—53 to 55 million tons against 60 million tons.

The targets set for some of the main industries in the metallurgical field are as follows, during Third Plan.

**Public Sector**

Steel—8.9 million tons to be achieved largely through expansion of existing units. This may go up to 10 million tons even depending on the availability of additional resources.

Special Steels—Raised up to 80,000 tons of additional capacity against half this figure as earlier contemplated.

Expanded Metal—6,000 tons against 2,000 tons in Second Plan.

Coal—95 million tons.

Power—12 million kW.

**Private Sector**

Special Steels—1,00,000 tons.

Refractories—1.75 million tons from 8,60,000 tons in Second Plan.

Aluminium: 82,000 tons from 25,000 tons in Second Plan.

**Steel**

Developments under iron and steel will be realised in the public sector mainly through Bhilai, Rourkela and Durgapur steel works, contributing jointly an

additional 2.5 million tons of steel ingots over the level of 6 million tons programmed under the Second Plan and 1.2 million tons of pig iron. The scarp-based electric furnaces will produce additionally 2,00,000 tons of ingots and the low shaft blast furnaces will produce 2,00,000 tons of pig iron. Rs. 300 crores are allotted for the iron and steel programme in the public sector. This development of production facilities for alloy and tool steel needs to be assigned very high priority.

The Planning Commission has estimated the finished steel requirements for construction in the next Plan to be 13.06 million tons and in the Fourth Plan 19.74 million tons. The total requirements in the last year of the two Plans have been placed at 7.8 million tons and 12.6 million tons, respectively. In 1965–66 construction will account for 3.2 million tons, inventories 0.4 million tons, manufacturing industries 3.7 million tons, defence 0.3 million tons and exports 0.2 million tons. The figures for 1970—71 are construction 4.9 million tons, inventories 0.6 million tons, manufacturing industries 6.1 million tons, defence 0.5 million tons and exports 0.5 million tons.

The Steel, Mines and Fuel ministry has tentatively envisaged a target of about 10 million tons of steel for Third Plan and this 10 millions tons of steel is to be achieved by the expansion of existing units and by the new plant at Bokaro. Because of the increasing demand of pig iron, the Bokaro plant must be taken up during the next plan; otherwise there will be a shortage of 1.2 million tons of steel and 8,00,000 tons of pig iron by 1965.

**Special Steels**

The Union Government has made plans to set up an alloy and Tool Steel Plant with an initial capacity of 80,000 tons of ingots a year, calculated to yield 50,000 tons of finished products at a cost of 35 crores and this plant will be capable of rapid expansion to 1,60,000 tons of ingots a year. India's requirement of alloy and tool steel by the end of the Third Plan was assessed at 50,000 and this may go up to 1,80,000 tons as per private sector's estimate. Therefore to fill up gap of 1,00,000 tons, Tatas would like to set up a plant at Jamshedpur with the capacity of 1,00,000 tons of ingots or 60,000 tons of finished steel a year.

Apart from this, the Government of India has sanctioned eight parties to put up small pig iron plants: three in Bombay, three in Madras and one each in Orissa and West Bengal.

**Coal**

For a capacity of 10 million tons of steel and 2 million tons of pig iron the requirement of coaking Coal and semi-coaking Coal is 19 million tons and 6 million tons respectively. Apart from the steel plants the two main consumers of coal will be the railway (22 million tons) and the thermal power stations (10 million tons). The production of Coal will rise to 54 million tons as against the original target of 60 million tons and under Third Plan another 40 million tons will be increased half in the private sector and half in the public sector. The expansion of lignite production both at Neiveli and Palana is undertaken.

**Aluminium**

Two aluminium production projects are being set up in the private sector which will rise the production by 30,000 tons annually and it involves foreign exchange investment to the extent of Rs. 17 crores which is being provided by foreign collaborators. It is hoped India will be able to produce 85,000 tons during the Third Plan period. Of the two proposed aluminium production plants one will be set up in Ratnagiri district, Bombay with American collaboration and its annual production capacity being 20,000 tons. The plant will use hydro-electric power from Koyna power project and use the bauxite deposits in Udgeri Dhangarwadi and Rangwadi nearby.

The second plant is being examined by the Union Commerce Ministry and this plant will manufacture 10,000 tons of aluminium at Salem with Italian collaboration and the Madras Government will purchase shares of the firm setting up the plant.

**Atomic energy Plant**

An atomic energy plant costing Rs. 10 crores at or near Janjira Murud and a steel plant operated on atomic energy costing Rs. 10 crores at Ratnagiri district have been included in the Third Five Year Plan.

**Sulphur from pyrites**

The National Industrial Development Corporation has set up a subsidiary company—The Pyrites and Chemicals Development Ltd., for the manufacture of sulphur, sulphuric acid and other products from the pyrites at a cost of Rs. 6 or 7 crores. 200 to 300 tons of sulphur per day will be produced by smelting the pyrites ore.

**Copper Smelter**

A copper smelter with a capacity to produce 10,000 tons of copper is expected to start functioning during the Third Plan period at a cost of Rs. 10 crores.

**Heavy plates and Vessels**

Two plants are proposed to be set up in the public sector—one for manufacture of heavy structural fabrications and the other for heavy plates and vessels at the cost of Rs. 7 and 8 crores respectively.

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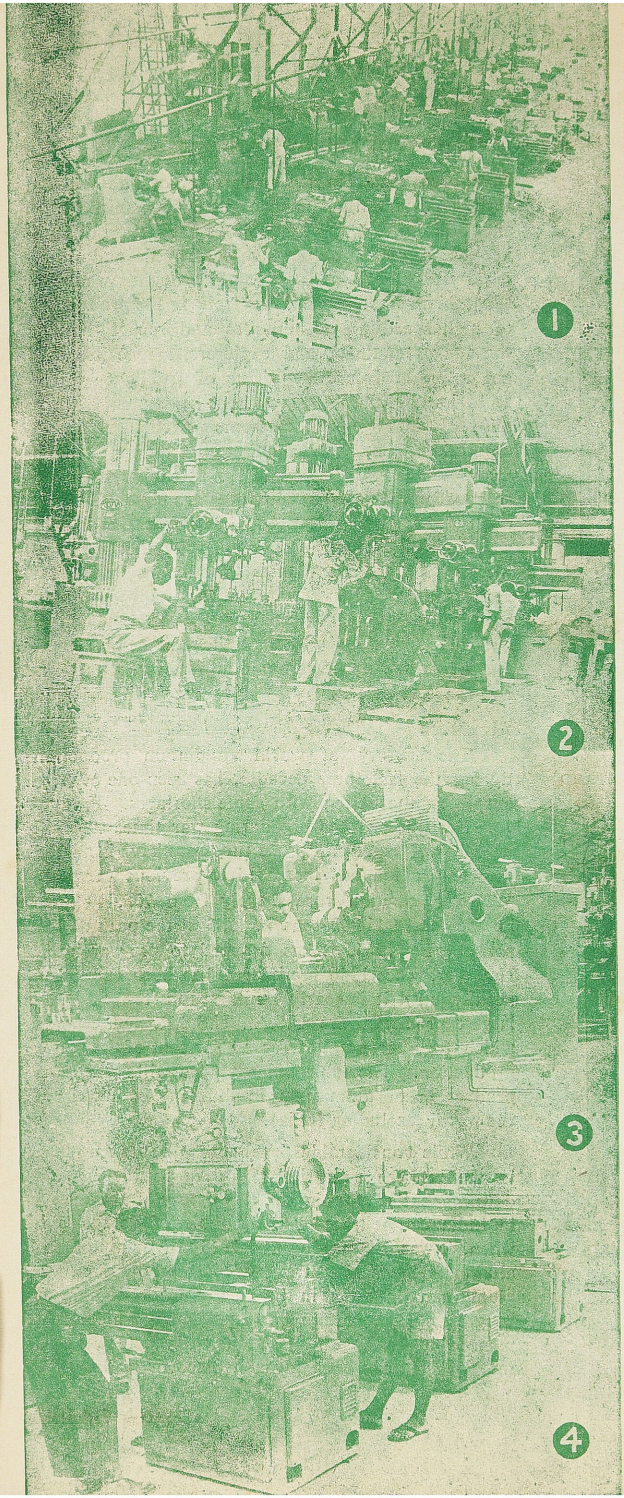


# ENGINEERING SECTION

# Development of Light Metal Industry in India

P. K. GUPTA
Senior Scientific Officer

AND

K. N. SRIVASTAVA
Senior Scientific Officer
National Metallurgical Laboratory,
Jamshedpur—7

During the last decade, considerable strides have been made in the technology of light metals such as, aluminium, magnesium and titanium etc., and billions of these light alloys are being utilised in the aircraft, automotive, electronic and other industries, both as cast and wrought products. Magnesium has earned a key role in the production of high speed planes, missiles and rockets and in the age of sputniks and explorers, magnesium has got a bright future by virtue of its light weight and its amenability to heat treatment when alloyed with other elements particularly with aluminium, zinc, zirconium etc. Titanium and its alloys have also acquired great importance as wonder metal of the present age due to their excellent corrosion resistance properties and light weight combined with strength. Beryllium-another member of the light metal family which was till recently regarded as a rare metal, has been found as valuable alloy in atomic reactors as a moderator and reflector along with graphite and heavy water, and a possible structural material in aircraft, missiles and space vehicles.

**Aluminium**

The history of world aluminium production during the last three decades, has been one of large surpluses alternating with acute shortages. Production has jumped sharply during war time, slumped at war end, then again peace time uses have increased and production has increased to previous war peak. World production rose sharply from 705,000 tons in 1939 to 1,946,000 tons in 1943 at the peak of war period. By 1946, it has dropped to pre-war level. However, since 1946 production has been increasing rapidly until it is nearly 4 million tons to-day. The largest producers are U.S.A., U.S.S.R. and Canada which together account for 80 per cent of the world production. The table in next page will furnish the production of aluminium in different countries of the world (excluding India)

While considerable development has taken place in the western countries regarding production and development of aluminium, the history of aluminium in India can be traced only a couple of decades ago when, it was first produced in 1943 utilising imported alumina. Since the time of its production, the aluminium industry in India has made significant progress. Manufacture of virgin metal which commenced in 1943 with 1,275 tons, rose to 17,250 tons in 1959. It has been given a place of pride in the

World Production of Aluminium (000, tons)

| | 1955 | 1956 | 1957 | 1958 | 1959 |
|---|---|---|---|---|---|
| Australia | 1.2 | 9.1 | 10.6 | 10.9 | 11.4 |
| U.S.A. | 1,397.0 | 1,499.1 | 1,471.2 | 1,397.8 | 1,743.7 |
| Canada | 546.9 | 553.9 | 497.1 | 566.2 | 535.2 |
| Fed. Rep. Germany | 134.9 | 145.0 | 151.4 | 134.6 | 148.7 |
| France | 127.4 | 147.4 | 157.3 | 166.2 | 170.3 |
| Norway | 70.6 | 90.5 | 94.1 | 119.4 | 142.6 |
| Italy | 60.5 | 62.4 | 65.1 | 63.0 | 73.8 |
| Japan | 56.6 | 65.0 | 66.9 | 82.2 | 98.6 |
| Austria | 56.3 | 58.5 | 58.5 | 56.00 | 64.7 |
| U.K. | 24.4 | 27.6 | 29.4 | 26.5 | 24.5 |
| Switzerland | 30.0 | 30.0 | 31.0 | 31.0 | 33.8 |
| U.S.S.R. | 424.0 | 425.0 | 490.0 | 540.0 | 558.0 |
| Hungary | 37.0 | 34.3 | 25.6 | 40.0 | 43.0 |
| | 3,100.0 | 3,300.0 | 3,300.0 | 3,400.0 | 3,925.0 |

third Five Year Plan period when a target production of 82,500 tons of aluminium is envisaged.

**Raw material Resources of India**

The main raw materials for the aluminium industry are bauxite, electrical power, petroleum coke, cryolite, fluorspar, caustic soda etc.

**Bauxite**

Bauxite is found in many places in India. The total bauxite resources of India are estimated at 250 million tons out of which about 25 million tons are reported to be of high grade, 50% $Al_2O_3$ and over. One important bauxite bearing mountainous belt, extent from Lohardaga, Bihar, in the east through the districts of Jashpur, Surguja, Koira and Rewa, upto Balaghat, Mandla area in Madhya Pradesh in the West. The deposit at Lohardaga are at present being exploited for use in alumina plants of Indian Aluminium Company and Aluminium Corporation of India Ltd. Another bauxite bearing belt extends from north of Bombay city along the western ghats through Kolhapur upto Belgaum and beyond. Resources of bauxite of various grades in this region are estimated to be about 30 million tons. A third belt which may prove to be of importance is located along the coastal run of Gujerat. A rich bauxite belt in the Vindhya Mountains in U.P. has also been located where M/s. Hindustan Aluminium is building up its 20,000 ton aluminium smelting plant.

There are several other bauxite deposits in India. e.g. Katni area in Madhya Pradesh, the Eastern Ghats, north of Visakhapatnam, Shevaroy Hills in Madras, Sambalpur in Orissa, in Bhopal and in Kashmir State.

Bauxite found at various places in India varies in composition and properties and presents certain chemical peculiarities which are not generally found in bauxites elsewhere in the world. In North and South America, nearly all bauxites are trihydrates. In Europe, practically all bauxite is of monohydrate type, generally high in iron oxide. In Africa, bauxite is of trihydrate type, similar to that of America. In India, unhappily, there is no uniformity in this respect. Although Indian Bauxite is mainly of the trihydrate type, varying amounts of monohydrates are often found mixed with the trihydrates. This lack of uniformity applies to most of the constituents of the Indian bauxite, such as, water and iron oxide, titania, silica etc. Thus bauxite found in Lohardaga area is high in titania (10%) but those in Gujarat, Shevaroy and Kashmir are relatively low in titania (2–4%). The Kashmir bauxite with low percentage of loss on ignition is essentially a monohydrate bauxite (diaspore), difficult to digest in caustic soda and thus not very suitable for treatment by Bayer's process. The bauxite in the Lohardaga-Balghat belt appears to be a mixture of monohydrate and trihydrate, with trihydrate predominating to the extent of 70–80%. The bauxite's solubility in caustic soda is fair, but the most easily soluble bauxites are the trihydrate varieties and it is believed that Gujerat and Shervaroy bauxites are of this type. Typical analysis of various Indian bauxite deposits are given in the table in the next page :—

| | Lohardaga | Belgaum | Katni | Shevaroy | Gujerat | Kashmir |
|---|---|---|---|---|---|---|
| $Al_2O_3$ % | 53–58 | 53–58 | 53–58 | 50–55 | 58–62 | 70-80 |
| $Fe_2O_3$ % | 8–10 | 6–8 | 5–7 | 4–6 | 2–6 | 1–3 |
| $TiO_2$ % | 8–10 | 6–8 | 5–7 | 1–3 | 1–3 | 1–3 |
| $SiO_2$ % | 1–3 | 1–3 | 1–3 | 15–20 | 1–2 | 5-10 |
| R. $SiO_2$ | 1–2 | 1–2 | — | 2–4 | 0–1 | — |
| L. O. I. | 25 | 27 | 27 | 27 | 33 | 12 |

Impurities like $Fe_2O_3$ and $TiO_2$ are insoluble in Caustic Soda and are left behind as insoluble red mud which is filtered off, washed and dumped outside. These impurities, however, do not interfere in processing of bauxite, except that if they are in large percentages, the amount of red mud produced will be large, requiring bigger sized mud-handling equipment and resulting in increased soda loss to the red mud pond. Also with more impurities the tons of bauxite required to produce one ton of alumina will increase resulting in increased bauxite mining cost.

When it comes to silica as an impurity in bauxite, one has to be careful since the chemical form in which silica is present in bauxite can materially affect soda and alumina losses during digestion. If silica is present as $SiO_2$ - quartz, it is normally harmless, since it is insoluble in caustic soda and does not interfere in Bayer's process. If silica, however, is present in bauxite as an alumina-silicate, it will combine with soda and alumina during digestion of bauxite forming insoluble sodium alumino-silicate which is then eliminated from the process into the red mud increasing soda and alumina lossses. Since soda is an expensive material, it renders the process uneconomic. Normally it is not economical to process bauxite containing more than 7% reactive silica. For every pound of reactive silica 1 to 2 lb. of alumina and same quantity of soda ($Na_2O0_3$) are lost. Most of the Indian bauxites contain relatively low percentage of reactive silica (about 2%), although it is believed that Shevaroy bauxite contains higher percentage of reactive silica.

The bauxite resources of India and determination of its amenability to purification by Bayer's process lead to consideration of the red mud which is treated as a waste product by the aluminium smelting industries. The red mud contains ferric oxide, titania, silica together with $Al_2O_3$ and soda which are tied up with reactive silica. Its average analysis is furnished below :

| | Red mud |
|---|---|
| L.O.I.% | 11–12 |
| Total $SiO_2$% | 4–5% |
| $Fe_2O_3$% | 20–24% |
| $TiO_2$% | 24–26% |
| $Al_2O_3$% | 18–20% |
| $Na_2O$% | 4–5% |

With the present rate of production of alumina, about 29,000 tons of red mud is obtained every year which is dumped as waste. Red mud (granulated type) is utilised in other countries as a catalyst for synthetic petroleum production, pig iron manufacture etc. As it contains considerable percentage of $TiO_2$ and $Fe_2O_3$, one of the profitable use may be utilising $TiO_2$ and $Fe_2O_3$ of the leached red mud in the production of ferro-titanium by Thermit process which will be of considerable importance to India, particularly in view of the proposed Alloy, Tool and Special Steel Plant to be established during the Third Five Year Plan period. Other probable uses may be smelting red mud with coke and soda ash in an electric furnace to recover all the $Fe_2O_3$ as saleable pig iron and to obtain a slag richer in $TiO_2$ & $Al_2O_3$ from which $Al_2O_3$ can be removed by digesting with dilute alkali solution and the residue may be suitable for $TiO_2$ pigment manufacture.

**Electric Power**

Electric power is another essential requisite of this industry. Normally about 10 units of electrical energy are required for each pound of aluminium. An aluminium plant must, therefore, obtain large blocks of electrical power, and it is essential that such power should be available at a very low cost. The present rate of power in India is also high which is Rs. 165/- to Rs. 125/- per Kw year as compared to Rs. 85/- to Rs. 125/- per Kw year in other countries. It will therefore be difficult for the aluminium industry to meet the country's ever-increasing demand of aluminium unless the power problem is solved. Considering all these factors, a proposition may be made to study the possibilities of reducing the power consumption in the cell by following the developments that have taken place in foreign countries.

**Petroleum Coke**

The requirement of green petroleum coke by the end of Third Five Year Plan will be of the order of 1,00,000 tons per year. At present, Assam Oil Company of Dighboi are the only producers of petroleum coke. It is understood that the two proposed Public Sector oil refineries being set up at Gauhati and Barauni will produce raw petroleum coke with a capacity of 38,000 tons and 67,000 tons

and are expected to be in operation in 1962 and 1963 respectively.

**Cryolite and Fluorspar**

At present both the materials are imported. Although there is no deposit of cryolite, synthetic cryolite may be made in the country. Large deposits of fluorspar have been reported from Dungarpur district in Rajasthan. It has been estimated from the deposit so far prospected that about 2.5 million tons of fluorite ore containing about 20-30% $CaF_2$ exist. Further prospecting is expected to increase the reserve considerably.

Caustic Soda: The target of production by 1965-66 has been kept at 300,000 tons per year. It is expected that the indigenous production would be able to meet the demand of the aluminium industry.

**Production, Consumption and Demand of Aluminium**

At present, the factories producing aluminium metal are managed by the Indian Aluminium Co. and the Aluminium Corporation of India. The Indian Aluminium Co. has its works at four different parts of the country-the alminium factory with thermal station at Muri (Bihar), aluminium smelter at Alupuram (Kerala) and Hirakud (Orissa) and the rolling mills at Belur (Bengal). The following table will give the production, import and consumption of aluminium in India in recent years :—

| Year | Production (Tons) | Import (Tons) | Total Consumption (Tons) |
|---|---|---|---|
| 1951 | 3,840 | 10,500 | 15,000 |
| 1952 | 3,590 | 7,100 | 13,000 |
| 1953 | 3,760 | 4,800 | 12,000 |
| 1954 | 4,890 | 12,400 | 20,000 |
| 1955 | 7,225 | 15,800 | 27,000 |
| 1956 | 6,500 | 14,000 | 26,000 |
| 1957 | 7,780 | 17,300 | 33,000 |
| 1958 | 8,180 | 19,200 | 35,000 |
| 1959 | 17,250 | 19,000 | 40,000 |
| 1960 | 18,000** | 17,000** | 45,000** |

** Estimated

To meet the domestic demand mostly from the indigenous production, the expansion of the aluminium industry has been given a dominant place in the industrial programme under the third Five Year Plan. A target of 82,500 tons by 1961–66 is expected to be achieved as a result of the following projects which have been already recommended for implementation. Expansion of the Indian Aluminium Company plant in Hirakud by 10, 000 tons a year; Establishment of a 20,000 tons smelter in Rihand (Hindustan Aluminium Co.) Establishment of a 40,000 tons smelter in Koyna (M/s. Tendulkar Industries); Establishment of a 10,000 tons smelter near Salem (Madras Aluminium Co.); Expansion of the plant of the Aluminium Corporation of India by 5000 tons a year.

**Processing Industries**

*Aluminium Rolling Mills:* In the field of semi-manufacturing sectors, there were eight rolling mills in 1958, total capacity being 17800 tons a year. Future expansion programme of the rolling industry includes one of the Aluminium Corporation to increase its capacity for sheets and circles to 3900 tons/year and also to go in for production of new articles such as, aluminium foils (480 tons annual capacity) and aluminium extrusion (Annual capacity 960 tons) by 1962. Indian Aluminium Co. plans to instal new equipment to produce heavier foil stock coils weighing 1500lbs. each which are more suitable for high rolling mills and also to expand its capacity.

**Aluminium Wire Rod and Cable**

The main aluminium conductor manufacturing unit in the country is the Aluminium Industries Ltd., at Kundara in Kerala State which started manufacture in February, 1950. Production of aluminium conductors at Kundara has progressively stepped up from 1500 tons in the first year to over 4,000 tons in recent years. M/s. Electrical Manufacturing Co. Ltd., Dum Dum, have commissioned their plant in recent years for manufacture of aluminium conductors with an estimated capacity of 2,500 tons.

**Aluminium Foil**

M/s. Venesta Foils Ltd. is the only unit at present manufacturing aluminium foils. Its capacity for the manufacture of foils and container sheets is about 3,500 tons per year. The firm has also plan to increase its capacity to 4100 tons during 1961 and further 2,000 tons during the third Five Year Plan.

**Powder and Paste**

The Indian Aluminium Co. Ltd.'s Aluminium Paste Plant at Kalwa, 26 miles from Bombay City, commenced production in December, 1951. The plant is designed to produce 300 tons of pastes per annum and 300 tons of powder in addition to the quantity required for the paste industry.

**Capsules, Food Containers etc.**

Aluminium Capsules Ltd., a subsidiary of M/s. Larsen & Toubro Ltd., are manufacturing aluminium capsules, since 1948 in Bombay and have a capacity of 500 lakhs of capsules per annum. The Metal Box Co. Ltd. at Calcutta have started large scale production of aluminium collapsible tubes for tooth

paste and drug industries and aluminium containers for packing industries.

**Utensils**

The utensil industry has been consuming so far the major percentage of aluminium either produced in this country or imported from abroad. The demand for this industry of approximately 8,000 to 10,000 tons per annum which has been steady till 1952, has diminished to some extent due to the falling demand in foreign and home markets for finished utensils.

The following table will give an idea of the present capacity and estimated consumption in 1965–66 of aluminium under various categories of uses:

| INDUSTRY | 1955 (Tons) | 1960 (Tons) | Estimate by the Development Council for Non-ferrous Metal (tons) | Present Estimate of the Development Wing (Tons) |
|---|---|---|---|---|
| Building & Construction | 480 | 3,000 | 5,000 | 6,000 |
| Transportation & Aluminium Alloys | 2,350 | 7,000 | 15,000 | 20,000 |
| Household and other commercial supplies | 11,550 | 11,000 | 20,000 | 30,000 |
| Electrical industries | 8,980 | 16,000 | 35,000 | 50,000 |
| Food, Farming & sugar industries | 15 | 1,000 | 2,500 | 3,000 |
| Canning & Packing | 2,580 | 3,000 | 7,500 | 10,000 |
| Miscellaneous | 1,345 | 4,000 | 5,000 | 9,000 |

**Future trends in Application of Aluminium in India**

With the expansion of the aluminium industries in the country, the metal will find varied application, trend of which will be broadly in the railways, in motor vehicles, in building and construction, in electrical cables, in packing etc.

**Recommendations for aluminium industry in India**

Price factor plays an important part in the development of demand for any product. It is more so in India where great stress is laid on the initial cost as opposed to long term economics. Aluminium costs 30 to 40% more in India than in any other developed country. Further, the price differential between aluminium and other competiting materials is far more unfavourable in India than elsewhere. If aluminium is to establish itself especially in the next few years, when the supply of steel is expected to increase, it is essential that price should be brought down. But the Indian Aluminium Industries are faced with many adverse operating and other conditions e.g. high processing cost of bauxite, high charges for electric power, freight etc. which stand in the way of decreasing the production cost. While the reduction in cost of power (Rs. 165 per Kw year as compared to Rs. 85/- to Rs. 125/- per Kw year in other countries), improved transport facilities and reduction in freight charges etc. should be considered by the respective State Govts. and Ministry of Railways, the industries may consider the following suggestions for lowering the production costs :—

1. To increase the existing plant capacities to 60,000 tons/year. It has been estimated that unit costs of production of a 50,000 ton smelter may be lower by 15% than those of a 20,000 ton plant. By having larger size plants operating costs will be correspondingly reduced and this will ensure that aluminium holds its ground in competition with other metals.

2. Recently an announcement has been made by the Aluminium Ltd., of Canada (Alcan) regarding a basically new process of manufacturing aluminium metal directly from the bauxite thus bypassing the present alumina from bauxite extraction step and eliminating the big investment required by the conventional Bayer's process. In essence, instead of separating impurities in the alumina extraction plant, $Al_2 0_3$ is reduced to metal in the presence of all the impurities in the ore, then the metal is distilled out. M/s. Alcan does not reveal how the bauxite is reduced, and they are trying the new process on experimental scale installing a plant with 8,000 tons annual capacity. The new facilities are believed to be available in two years' time. The adoption of the new technique for the future aluminium plants of the country will have substantial bearing on lowering the production cost of alumina.

Another way of expanding the industries and side-stepping the effect of shortage of power, is to develop the finishing side of the industry. It may be an interesting proposition to export processed alumina to countries like Norway, Switzerland and Japan who have established smelting industries without any bauxite resources of their own, and to import aluminium ingots on toll basis from them for processing the metals in Indian Mills to turn out various finished and semi-finished products. Such a step may prove beneficial till the country's output of electrical power is increased considerably and can be obtained at a much cheaper rate.

The above factors when given due consideration will, apart from bringing down the manufacturing cost of aluminium, also help in finding a larger export market of Indian aluminium products. At present, India is exporting aluminium semis worth Rs. 1,20,000 and domestic utensils for about Rs. 45 lakhs to South East Asia, Middle East and African countries. A larger export trend cannot be expected at this stage as the industry itself is not in a position to meet the internal demand and needs Tariff protection.

**Magnesium**

Magnesium is the eighth most abundant element and the fourth most plentiful metal in the earth's crust, where it is present to the extent of 2.2 per cent. Sea water contains 0.13% magnesium metal, so that one cubic mile of sea water represents 5½ million tons of the metal combined as a salt. The reasons for the very late appearance in our history of this metal so lavishly provided by nature are the same as those given for the tardy arrival of aluminium. Both these light metals awaited the development of industrial electrolysis; but whereas aluminium is made solely by that method, alternative procedures for reduction of magnesium are practised now along the electrolytic process. The largest tonnage of magnesium to-day is however extracted from the sea water adopting electrolysis method, by Dow Chemical Company of U.S.A. and Norsk Hydro-Elektrisk Kvoclato-Faktieselskap of Norway.

The United Kingdom was the first country in Europe to produce magnesium in small quantity for photographic purposes. Germany began to produce magnesium commercially on an industrial scale, and developed alloys for use as engineering materials. The results of the German work, supported by that of U.K., France and Italy, gave Europe the lead for some years in the production and usage of the metal for engineering purposes. Between the years 1929 and 1938, in addition to aircraft and military application a fairly wide range of produce for civilian usage became firmly established.

From about 1939 onwards, the Dow Chemical Company of America began steadily to increase production of magnesium and its alloys and the efforts of that Company stimulated by the great demand of World War II, enabled U.S.A. rapidly to become the leading producer and consumer of magnesium in the world, a position which she still holds to-day.

In 1938, the world's annual production of magnesium was only 32,000 tons, as per the breakdown given below :

| | | |
|---|---|---|
| Germany | About | 20,000 tons |
| U.K. | ,, | 5,000 tons |
| U.S.A. | ,, | 2,500 tons |
| France | ,, | 2,500 tons |
| Japan | ,, | 1,000 tons |
| Switzerland | ,, | 500 tons |
| Russia | ,, | 500 tons |
| | Total | 32,000 tons |

The enormous increase in demand for magnesium metal for war purposes, already visible in Germany, was met by rapid expansion of production facilities in the U.K. and still greater and more rapid expansion facilities in U.S.A. The approximate total quantity of magnesium produced by all countries for the year 1939–40 was 32,000 tons; the comparable figure for the period of 1943–44 was 228,000 tons, more than seven times that of 1939–40. Unfortunately the valuable properties of the metals were so little known that such tonnages could not be absorbed for civilian purposes, and so the fall in post-war production was even sharper than war-time rises in consumption, which has again come down to 95,000 tons in 1959. The world production figures for magnesium in different countries are given in the table next page :

**Scope for Development of Magnesium Metal Industry in India**

Magnesium is not being produced in India and the country's entire requirements are solely met by import both as virgin metal and fabricated components. Considering the raw material resources for the production of magnesium metal, India can be considered to be in a happy position so far as the ores of the metals are considered.

The occurrence of dolomite is very wide spread and the best known deposits exist in Birmitrapur and Panposh areas in Sundergarh district of Orissa which account for 97 per cent of India's total production. The resources of the ore in this area are estimated as 250 million tons. The output of dolomite was 325,000 tons in 1959 which is mainly consumed by the

World production of magnesium metal, by countries, in short tons.

| | 1950 to 54 average | 1955 | 1956 | 1957 | 1958 | 1959 |
|---|---|---|---|---|---|---|
| Canada | 4,982 | 7,700 | 9,606 | 8,385 | 6,796 | 5,817 |
| China | — | — | — | — | 1,100 | 1,100 |
| France | 989 | 1,670 | 1,660 | 1,750 | 1,897 | 1,931 |
| Germany, West | 154 | 144 | 194 | 260 | 208 | 214 |
| Italy | 956 | 3,161 | 4,097 | 4,162 | 4,607 | 4,630 |
| Japan | 23* | 148 | 86 | 472 | 1,106 | 1,655 |
| Norway | 1,942 | 7,433 | 8,185 | 9,504 | 10,226 | 10,250 |
| Poland | 61* | 103 | 158 | 150 | 165 | 165 |
| Switzerland | 231 | — | — | — | — | — |
| U.S.S.R. | 36,800 | 45,000 | 45,000 | 45,000 | 45,000 | 45,000 |
| United Kingdom | 5,081 | 6,054 | 4,000 | 3,831 | 2,691 | 2,458 |
| United States | 65,046 | 61,135 | 68,346 | 81,263 | 30,096 | 31,033 |
| World Total (estimate) | 118,400 | 132,800 | 141,600 | 155,000 | 103,900 | 104,300 |

* One Year's production.

iron and steel industries. Indian dolomites contain-$MgO$–20 to 26% $CaO$–30%, insoluble less than 3% and alkalies—trace, are quite suitable for magnesium production employing silico-thermal process.

Magnesite ore, the other magnesium bearing mineral, also occurs in many places in India but so far only the Salem, Mysore and Almora deposits appear to be workable. Reserves of the Chalk Hills deposits are roughly estimated at 90,000,000 tons analysing over 96 per cent $MgCO_3$ (46.4%) Mg.). Annual mine output is about 30,00–40,000 tons, part of it being used for refractories and a large quantity is exported. Almora reserves are estimated at least 20,000,000 tons.

There are certain inherent difficulties associated with the extraction of magnesium metal from magnesite by pyro-metallurgical technique. The reduction of $MgO$ is to be effected at a much higher temperature than that required for dolomite, e.g. 1150–1200°C. The magnesite is also to be reduced by carbon and magnesium has to be recovered by shock-cooling tratement as otherwise a back reaction results with the formation of magnesium oxide and carbon. Magnesium is obtained in a powder form, pyrophoric in nature and has to be carefully remelted and then used.

The present demand of virgin metal on a very liberal estimate is of the order of 200 tons/year. To meet this requirement and also needs in near future, the adoption of silico-thermal process of reducing dolomite seems to be the most convenient process of manufacturing magnesium under the existing raw material conditions. But scope also exists in India for the production of magnesium metal by electrolysis from magnesium chloride which is obtained as bye-product in the chemical industries and do not have any commercial market. Depending on the demand of the metal, availability of power etc., choice is to be made on the specific adoption of techniques. The electrolysis process which is a continuous one can be adopted advantageously when the demand is quite large.

### Titanium Beryllium, and Zirconium

The majority of the titanium mineral produced in India are exported in raw form and a very small proportion of the order of 3,000 tons a year is utilized for the manufacture of titanium dioxide pigment by M/s. Travancore Titanium Products at Trivandrum. Although no possible scope now exists for the manufacture of titanium metal in India in the near future, there is great potentiality for starting production of ferro-titanium in the country in the background of alloy, tool and special steel plant which is being established during the Third Five Year Plan period.

Deposits of both beryllium and zirconium occur in India which was once the only source of world's supply of beryl. The present day use of beryllium in the atomic energy has added more significance to this metal. The main source of zirconium is zircon sands. There is a good scope in India for the exploitation of the zirconium sands for the production of zircon refractories.

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* * *

# Possibilities of A Silicon Industry in India

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In 1924 two American scientists, Clarke and Washington, collected samples from various places of the earth upto a depth of 10 miles. They analysed these samples and determined from the results the average composition of the earth's crust as follows :

| | | | |
|---|---|---|---|
| Oxygen | 47% | Titanium | 0.6% |
| Silicon | 28% | Manganese | 0.1% |
| Aluminium | 8% | Other elements in quantities varying from 0.0000001% (Gold) to 0.05% (Barium) | |
| Iron | 5% | | |
| Calcium | 4% | | |
| Potassium | 3% | | |
| Magnesium | 2% | | |

The total quantity of the earth's crust, whose average composition is represented by this analysis, weighs about 17 x $10^{18}$ tons and the total weight of silicon in it is about 4.76 x $10^{18}$ tons.[1]

It is apparent from the above analysis, that silicon, existing in the form of its oxide, is the most abundant element in the earth, as has been confirmed also by the fact that no country has ever complained any shortage of it.

Silicon is an electropositive element. It occupies the 14th place in the periodic table of elements and is included in group 1V B along with carbon, germanium, tin and bismuth. It is bluish grey having bright metallic lustre and is extremely brittle. It is a tetravalent element with diamond cubic structure, and although used extensively for alloying with metals, because of its non-metallic nature of atomic bonding, is considered a metalloid. Atomic weight and specific gravity of silicon are 28.06 and 2.42 respectively and silicon melts at 1420$^0$ C and boils at 3500$^0$ C. [2]

Although he could not decompose silica (oxide of silicon—$SiO_2$) Lavoisier assumed it to be an oxide of an unknown metal. Davy in 1808 decomposed silica with iron and carbon, thereby producing the now famous and indispensible in steel making, ferrosilicon. He named silicon as "Silex" although he could not isolate it. Fifteen years later, in 1823, Berzilius isolated silicon, determined some of its properties and named it "Kiesel"[3]. Eighty four years later, in 1907, Carborandum company of the U.S.A. produced commercially 98% pure silicon[4] and that too as a by-product in the manufacture of carborandum. The product was not marketable at all[5]!

Commercial silicon now-a-days is principally used in alloys based on metals like aluminium, copper and nickel. Majority of the aluminium alloys

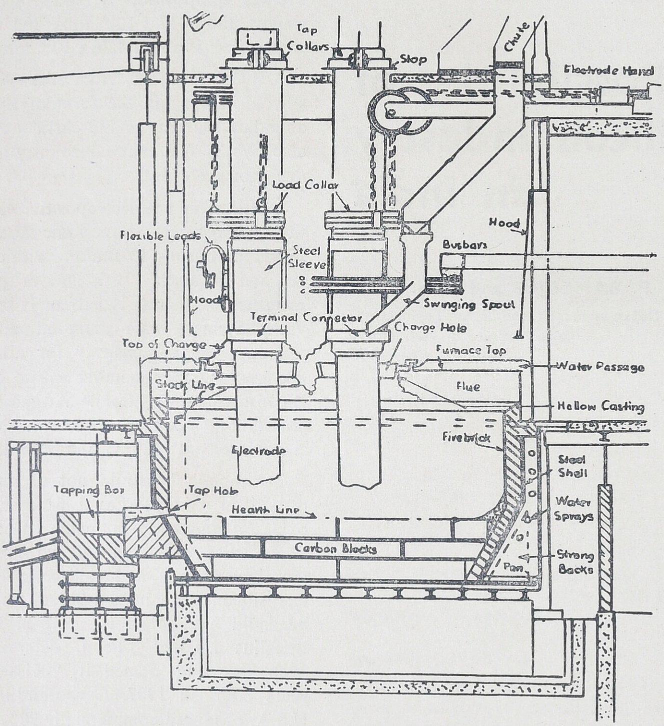
for casting and heat treatment contain from 1 to 10% silicon. Silicon bronzes which are corrosion resistant and stronger than brasses and ordinary bronzes contain upto 4% silicon and are extensively used in chemical plants and equipments.

99% pure silicon is used as a starting material for manufacture of various types of rubber, resin, oil and grease of silicone, which because of their peculiar and distinctive properties, are finding wide, varied and important applications in different industries: the prominent use being as greases for lubrication at very high and low temperatures and as insulating material in electrical machines which get heated upto 500° C.

Silicon of controlled purity is used in the manufacture of semi-conductor devices such as rectifiers, transistors and solar batteries.

The other two forms of silicon which are important to industries are Carborandum and Ferrosilicon. Carborandum is the carbide of silicon used as referactory, abrasive and heating element in electric muffle furnaces operating above 1000° C: and Ferrosilicon an alloy of a iron and silicon is invariably used for deoxidizing molten steel and in producing electrical steels and heat and corrosion resistant steels and cast irons.

Silicon is commercially produced by electrothermic reduction of silica or quartz, preferably by charcoal or by any of graphite, coke, anthracite and coal, in a submerged arc-type furnace of the type shown in the accompanying figure[6], the chemical reaction involved being, $SiO_2 + 2C = Si + 2CO$, above the melting temperature of silicon.




A FERRO-ALLOY FURNACE[6]

The most attractive feature of this process of manufacture is that the other two important silicon compounds, silicon carbide and ferrosilicon can be produced by suitable control,

in the same furnace, according to following reactions :

**a) Carborandum (Si C)**

The net reaction is $Si\ O_2 + 3C = Si\ C + 2CO$ possibly taking place in two stages as, $Si\ O_2 + 2C = Si + 2CO$ and $Si + C = Si\ C$. Silicon carbide is formed at the temperature range of 1600—2600° C, the raw materials being same as those used in production of silicon.

**b) Ferrosilicon (Fe Si)**

Steel scrap is added to the same raw materials used in production of silicon and ferrosilicon is obtained by the chemical reaction, $Fe + Si\ O_2 + 2C = Fe\ Si + 2CO$. Liquid ferrosilicon is tapped from the furnace at 1550—1700° C.

By similar reactions and in the same furnace, silico-manganese and other ferro-alloys required for manufacture of alloy steels may be produced as well.

It may be mentioned that ferrosilicon can be produced in conventional blast furnace but the grade is poorer.

At present, India is not producing any silicon or silicon carbide. In 1960, 116 tons 13 cwt. silicon valued at Rs. 2.749 lakhs was imported from various countries, France being the major supplier. Mysore Iron and Steel Works, the only producer of ferrosilicon, produced 5000 tons worth about Rs. 0.5 crores in 1958, and is expected to meet the full requirements of ferrosilicon by the end of second plan period. Although there are a number of coated-abrasive manufacturers in India, the total amount of carborandum imported annually could not be obtained while preparing this article.

Without full details of the production targets of various engineering industries in the third plan, it is difficult to assess accurately the economic aspects of setting up a silicon industry in India. But even then the situation is strongly favourable, as will be apparent from a general discussion of the trend of requirements of silicon, ferrosilicon, and silicon carbide by the end of the third plan period.

**Requirement of Silicon**

The production of aluminium pig by the end of 1965 will rise to 82,500 tons from the present 17,500 tons, and fabricated material to 36,260 tons from 15,900 tons. It is expected that 19,000 tons will be used up in transport against the present figure of 6000 tons. If the present trend continues, the production of high strength sheets which contain about 1% silicon as a major alloying element will increase. India will be making aero-engine components, automobile pistons and other aircraft parts from alloys containing silicon as an important ingredient and in addition, if the existing light-metal foundries are expanded or new foundries are set up, the demand for elemental silicon is bound to rise considerably. Further, since there is shortage of copper and other non-ferrous metals, India should try to replace these metals and alloys by alloys of iron and aluminium, the two metals on which the development of the major metallurgical industries will centre. Already aluminium is replacing copper in power transmission (40,000 tons aluminium in 1965) ; more and more of the copper alloys containing tin and zinc may be replaced by aluminium alloys since the field of application of aluminium alloys is widening rapidly. Most of these alloys will contain silicon as a major alloying element. Copper-silicon alloys can replace many of the bronzes and brasses and by adding silicon, appreciable improvement in strength and hardness may be developed in inferior quality gunmetals to replace bronzes of high tin content. The availability of silicon cheaply and readily will give impetus to manufacture of silicones, a new and important secondary industry and thereby India will be able to profit by the research in other industrially advanced countries.

**Requirements of Ferrosilicon**

According to the practice followed in basic open hearth steel making, 4 to 5 cwt. of ferrosilicon containing 50% silicon is used to deoxidise 100 tons of molten steel to obtain a residue of about 0.15% silicon in general structural steel. With the production target of 10 million tons of ingot steel, about 20,000 tons of ferrosilicon, worth about Rs. 2 crores will be the minimum requirement in steel plants. At present whole of the total quantity of electrical steel containing 3—4% silicon used in the manufacture of electrical fans and motors is imported. By the end of 1965, the production of electrical machineries will certainly increase, thereby increasing the demand for ferrosilicon, if of course, electrical steels are to be produced in India. Steel foundries and electric steel plants, certain to increase in number and capacity as more and more good quality steel scrap will be made available, will require further quantities of ferrosilicon. Cheap and readily available ferrosilicon will help utilization of low-grade pig iron with larger quantities of steel scrap in iron foundries and will also promote production of heat and corrosion resistant steels and cast irons.

**Requirement of Carborandum**

In industrially developed countries, the manufacture of silicon carbide is a basic requirement for industry. Its use as abrasive and refractory has gained major importance in almost all engineering

industries particularly engaged in mass production. Within and after the end of the third plan period, existing engineering industries will expand and new industries have to be started for utilization of the semi-finished product of the steel plants. Consequently, consumption of abrasives and refractories will increase. It is not known whether the abrasive wheels now being produced in India will satisfy the needs of these industries and whether manufacture of carborandum in India is under contemplation. It will not be certainly too early to produce carborandum indegenously to open up new avenues of industrial progress and self-sufficiency. Indegenous carborandum will also relieve shortage of heating elements, the only of its kind now used in construction and maintainance of electric muffle furnaces working at temperatures above 1000$^0$ C.

It is, therefore, clear that not only there are urgent needs but also very bright prospects in India of an industry devoted to production of silicon and silicon compounds and the proposal deserves closer attention. Probably the proposed special steel plant in Durgapur will be producing ferrosilicon but that certainly should not be allowed to push to the background the importance of the requirements of the non-ferrous industry and abrasive and refractory industries which require elemental silicon and carborandum respectively.

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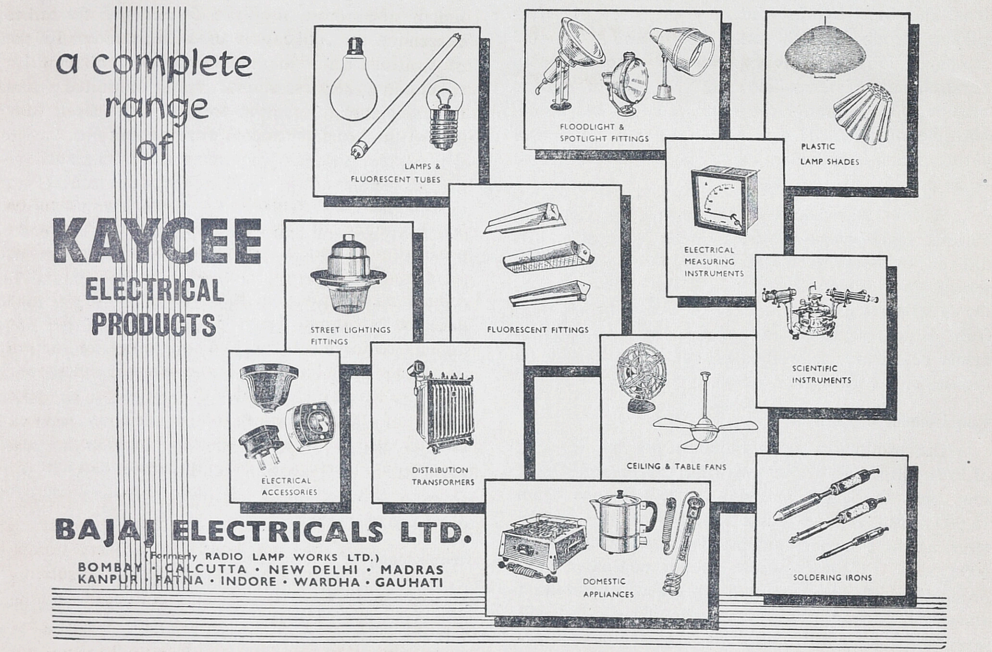

# Ten years of Glass & Ceramic Research

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With the advent of guided missiles and space rocketry, the hope is being pinned on research in ceramics to solve the technological problems of the materials for construction. Glass and ceramics were once a medium of expression for art and a measure of the extent of civilisation. Today, the achievements in the field of glass and ceramics are a measure of the technological advancement of a nation. In India, facilities for undergraduate and graduate teaching in glass and ceramics are available at the Banaras Hindu University and at the Indian Institute of Technology (Bombay). The Calcutta University, and the Osmania University have facilities for graduate courses.

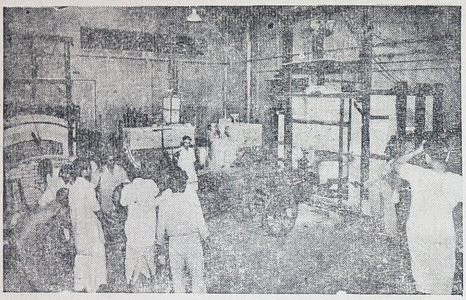
The main centre of research in glass and ceramics, in India, is the Central Glass and Ceramic Research Institute at Jadavpur (Calcutta). During the last ten years of its existence the Institute has been actively engaged in fundamental research and has given priority to problems having a direct bearing on the industrial needs of the country. The programme of applied research has been mainly concerning the survey and evaluation of raw materials, the methods for improving the quality of glass and ceramic products produced in the country, standardisation, the methods for testing which can be adopted in works practice, the substitutes for raw materials that are scarce in the country and whose supply may be cut off during emergency, the utilization of waste materials, the investigations into the possibility of producing in the country articles so far being imported, and the development of new products of special use. Some of the items of research are given below:

**Glass**

Amongst the research in glass, first mention may be made of Optical Glass. After extensive investigations optical glass has been successfully manufactured. All the equipment necessary for the production of optical glass have been designed and fabricated without any outside help. As an essential requirement for a whole range of optical instruments like binoculars, microscopes, telescopes, camera and firing control devices, optical glass is one of the key materials for defence services. Essential also for science, research laboratories and photography, it has many other important uses.

Foam glass, a unique light-weight thermal insulator has been developed. The product is extensively used in the building, air-conditioning and cold storage industries, as well as for insulating hot and cold pipes, tanks, etc., employed in the chemical and such other industries. Foam glass is fire and rot-proof and impervious to moisture

and vapour and does not (unlike cork) deteriorate during use. Potentialities of application of foam glass in a tropical country like India are vast.



*Molten optical glass in the pot, being taken out of the furnace*

For a hot country like India sun glare glasses, also known as goggles, are quite important. The essential requirement of sun glasses is that they should cut-off the ultraviolet and infrared portions of the spectrum, which are injurious to the eyes, and should reduce transmission in the visible region only to the extent of cutting off glare. After detailed investigations, compositions for making sun glasses which will meet the requirements expected of a good sun glasses under Indian conditions, have been worked out. Glasses for protection of the eyes during gas and electric welding operations have also been developed.

Processes for manufacture of signal glasses used on railways and for road traffic control have been worked out. Technique of making red glass bangles has been developed by using copper as the colorant instead of imported selenium. With the cooperation of producers and consumers, glass compositions suitable for the manufacture of ink bottles, distilled water bottles, mineral water bottles, milk bottles and fruit preservation containers have been worked out and these have been formulated so as to envolve practically no change in manufacturing operations. Methods for testing the quality of glass-containers before use, which are of interest to the consumer industries in selecting the proper quality containers, have also been worked out. Investigations have also been carried out on glass moulds, low melting heat resistant glasses, glass electrodes for pH meters, and conservation of selenium in decolorising of glass.

**Refractories**

With the expansion of iron and steel industry in India a considerable amount of investigation has been carried out on the refractories required by the steel plants. Investigations have also been carried out on hot face insulation, bauxite and spinel type refractories. Spinel type refractories will play an important role in construction of cement kilns.

Researches have been carried out on the comparison of test methods for spalling resistance of refractories, the improvement in the refractoriness under load of fire clay refractories, super duty silica refractories, super duty fire clay refractories, glasshouse refractories from Assam sillimanite waste, chrome alumina refractories, and stabilization of dolomite refractories.

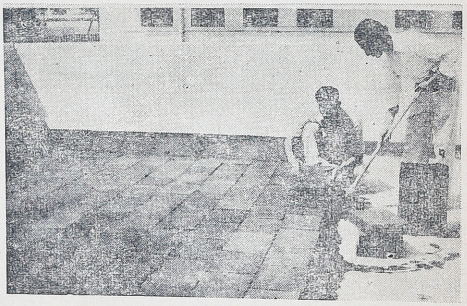
**Vitreous enamel**

One of the important ingredients of vitreous enamels is borax or other boron compounds for which no suitable source has so far been located in the country. After considerable investigations vitreous enamel compositions have been developed entirely without the use of borax or boron compounds. Boron-free vitreous enamels are of interest also in atomic reactors where boron due to its very high cross-section for neutron absorption may have to be avoided.

Vitreous enamels for coating high and low value resistors for electrical industries, enamels for enamelling of telephone dials, and single coat white vitreous enamels for direct application on steel have also been developed. One of the uses of the latter enamel is in enamelling of cast-iron thread-guides used in textile industries. Researches are being carried out on antimony-free white enamel, cobalt-free ground coat enamel, acid-resistant enamels, cast iron enamels, copper enamels, jewellery enamels, and colour stains for enamels.

**Mica**

Processes have been developed for manufacture of heat insulating bricks from waste mica. Heat insulating bricks are used as a backing meterial to



*Foam glass being laid on a roof for insulation against heat*

conserve heat in furnaces. Investigations have also been carried out on wet grinding of mica and on the utillisation of wet ground mica in paints. 'Heat resistant paints' incorporating ground mica have been evolved which are better than some of the very costly paints available in the market. The paints evolved withstand a temperature of 600°C. Researches on the use of mica in 'road marking paints' have shown that a substantial portion of the costly pigments presently used in the road marking paints could be replaced by mica po vder without any detrimental effect. In respect of some important properties like abrasion resistance and durability, the road marking paints incorporating mica are superior. Use of mica in 'fire retarding paints' has improved the fire resisting properties of the paints. Studies have also been undertaken for evolving 'exterior house paints' containing mica. An apparatus has been developed for rapid classification of mica based on its electrical properties. Investigations are being carried out on glass bonded mica products and the use of mica in paints and rubber industries.

**Ceramics**

Processes for manufacturing chemical porcelain from indigenous raw materials have been worked out. Chemical porcelain was being entirely imported into India. Investigations have also been carried out on the manufacture of porcelain portion of spark plugs for automobiles, low loss steatite bodies, dental porcelain, peeling of glazes, low temperature maturing stoneware pipes, shattering of sanitary wares, delayed crazing of wall tiles, ceramic colours, firing of translucent porcelain, zircon porcelain, water filter ceramic candles, and soldering of porcelain insulators. Investigation is being carried out on the replacement of borax in earthen ware leadless glazes. Plaster of Paris is an essential basic material used in the ceramic industries for making moulds in which the ceramic articles are formed. Different types of plasters are required for different forming operations. After detailed investigations, the conditions for marking good quality plasters of different types, for example, for casting moulds, for jigger and jolley moulds, for high strength pressure moulds, etc., have been established. The compositions and techniques for making improved quality saggars have also been worked out. Saggars are used as containers for firing ceramic articles in kilns.

**Fundamental research**

Some of the fundamental researches carried out are: study of the origin of red colour due to copper in glass; mineralogical studies of clays by d.t.a., ion exchange, infrared and X-rays; titania glasses; shortened methods for the analyses of silicates especially the polarographic and flame spectrophotometric methods; studies on phosphate systems; thermal expansion of oxides and glasses; polymerisation products of molybdenum and tungsten; optical absorption of glasses containing ions with partially filled 3-d orbitals; thermal conductivity of ceramic materials; influence of moisture on low temperature thermal insulating materials; dielectric constant, permittivity and power factor of mica; alumino-borophosphate glasses; manganese and iron oxides in glasses; and surface tension and thermal expansion of vitreous enamels.

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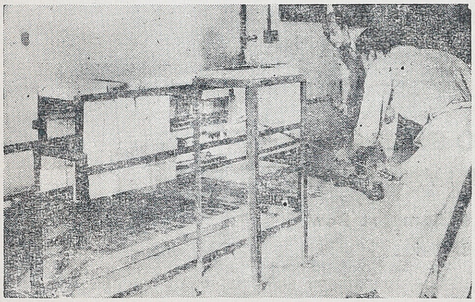

*Making spirals of selenium-free red glass Bangles*

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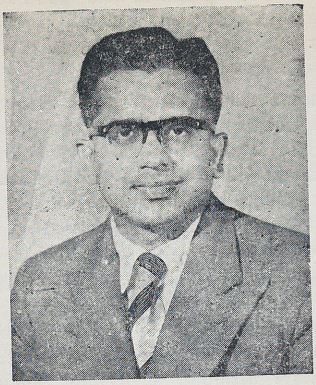

# Welding in India

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**History**

Among the many wonders of ancient India is the 1500-year-old Iron Pillar at Delhi consisting of pure iron ingots forge-welded together. Equally wonderful are the welded beams of the 13th century temple at Konarak which support the flat stone roof of the "Black Pagoda". The beams consist of 3-in. blocks of iron welded together to make long continuous beams 10 in. square and up to 20 feet long.

In spite of such inspiring traditions, India's welding industry remained in its infancy until the second world war, judged by comparison with the developments in West. True, attempts were being made by a few organizations and firms to popularise welding, but the industry came to accept and exploit welding processes only within the last decade when India began her rapid industrialisation under the Five-Year plans.

The year 1935 seems to have been of great significance. It was in this year that the Indian Railways undertook strengthening of a few bridges by welding. Besides, the Railways carried out some experiments on welding and the conclusions were presented in the form of two papers at the Proceedings of the Symposium on the welding of Iron and Steel held in London in 1935. In the same year, the North Western Railway published specifications for metallic arc welding as applied to mild steel bridge work. Again in this very year an associate firm of the British Oxygen Company Limited was formed in India, which has since played a significant role in the advancement of welding in India. This firm held its first welding exhibition here in 1938.

**Welding processes and materials**

The earliest welding materials produced indigenously were oxygen and acetylene. Oxy-acetylene welding process was and has been, therefore, widely used from the early days. In the field of arc welding, the first material to be produced indigenously in Calcutta was a light-coated mild steel electorde of the rutile type and this was the only type to be produced for the next two decades. Heavier coated mild electrodes, which had to be imported were, therefore, looked upon as special electrodes and were bracketed with alloy steel, hardfacing and non-ferrous electrodes and electrodes meant for repairs on cast iron. In 1952, a Bombay firm commenced production of a wide range of electrodes in collaboration with a famous Swiss

firm. The range included mild steel electrodes of the following types: cellulosic, basic or low-hydrogen, rutile-iron powder, low hydrogen-iron powder, iron powder deep-penetration, and a super-heavy coated iron powder type giving about 160% deposition efficiency. Besides, the firm began to produce low-alloy high tensile steel electrodes, hardfacing electrodes, monel and bronze electrodes, and nickel and monel base electrodes, for getting machinable welds on cast iron.

The first reaction of the Indian welder to heavy-coated mild steel electordes of Continental design was far from encouraging. Fortunately, at the same time, many Continental and other foreign technicians began to come over to assist India in many of her important projects under the First and Second Five-Year Plans. Engineers from Germany arrived in Jamshedpur to take charge of welding in a firm making locomotives and Mercedes-Benz trucks. Swiss engineers came over to Madras to help the the Indian Railways build all-welded integral coaches. Russian technicians began building a steel plant at Bhilai and German technicians began another one at Rourkela. A firm from Norway began building penstocks at several hydro-electric projects in South India. Canadian technicians took charge of fabrication and erection of an atomic reactor on the outskirts of Bombay. All these technicians began to set high welding standards and hundreds of Indian welders and supervisors received instructions from them. However, many of such projects began to prescribe codes of practice and standard specifications prevalent in the country which assisted it and consequently there was a danger of haphazard and uncontrolled development of the welding industries. The significant role of the Indian Standards Institution on co-ordination and standardisation of welding practices in this context will be described later.

Today, the Bombay firm and the Calcutta firm are the two principal electrode producers who are striving hard to meet India's continually growing demand, though a few important projects and firms obtain special licences for importing their requirements. According to a statistical survey[1], 237 million feet of electrodes were produced in 1958 and 271 million feet in 1959. During 1960, according to the author's estimate, over 300 million feet of electrodes (equivalent to 10,500 tonnes) were produced and consumed against the installed capacity of 420 million feet. The demand is much more than the production and the producers are carrying a heavy back-load of orders. According to the survey of the Council of Scientific and Industrial Research[2], India's demand for electrode core wire will be 13,000 tons during 1960—61, 22,000 tons during 1965—66 and 41,000 tons during 1970—71. This will give the reader an idea of the rate of development in welding in India in the coming years. The Government has recently given licences for the manufacture of electrodes to a few more firms in other cities of India.

Low-carbon rimmed steel wire for electrode core wire is still being imported from abroad in the form of billets. These are then rolled and drawn to required sizes in India. A steel firm in Calcutta has planned to produce this steel locally and with this development India will be self-sufficient in a very important raw material of the welding industry.

Electrical resistance welding machines in the form of spot welders, seam welders, butt welders and flash-butt welders, which are almost wholly imported, are in wide use. The Indian Railways operate at least two heavy flash-butt welders for joining rail ends. Recently, a few firms have started manufacturing small capacity pedal-operated and pneumatically operated spot welders. Welding transformers of reliable quality are being made increasingly by local firms. A Bombay firm will shortly go in for the manufacture of motor-driven welding generators in collaboration with a Czechoslovakian firm. Carbon electrodes arc welding and atomic-hydrogen welding are almost unknown in India.

**Automatic Arc Welding**

Automatic impregnated-tape metal arc welding installations of local manufacture and bearing an Australian patent were seen as early as in 1940 in a leading pipe fabricating firm in Bombay. Continuous cotton threads impregnated with iron oxide—manganese dioxide base flux with molasses serving as a binder were wound on two spools and these kept the end of the wire covered with flux before it reached the welding arc. These installations were used for the shop welding of penstocks laid at the hydro-electric projects at Jog Falls and Papanasam in South India. Around 1947, the firm began to change over to Unionmelt submerged-arc welding machines. Today, there are over 100 automatic or semi-automatic submerged-arc welding installations in the country. With increasing restrictions on the import of wire and fluxes, attempts are being made to use electrode core wire by copper-coating it locally, and to produce fluxes indigenously. At least two firms in Bombay have successfully produced fused and agglomerated varieties of flux.

Tungsten-inert gas process is also popular in shops which carry out stainless steel and aluminium fabrication work on a large scale. This process is preferred to metal-inert gas process because it enables one to use strips of plate material as filler metal. Recently, a firm in Calcutta has started producing argon gas locally and this factor should contribute

towards increasing use of TIG or MIG processes in addition to the factor that several fertilizer factories are coming up all over the country. Here again, the need will be felt for manufacturing inert-gas welding machines indigenously.

The most recent carbon dioxide-shielded semi-automatic welding process should have great appeal to the Indian user because of high welding speeds, clean welds and easy availability of dry carbon dioxide. This is more so as submerged arc welding has given frequent trouble under Indian conditions. Moisture and dirt carried by the granular flux in this process gives rise to weld porosity and this porosity can be detected only after the entire seam is welded and the flux and slag removed from it. Recently, a semi-automatic machine of Swiss design which can be used for welding carbon steels with carbon dioxide as a shield and also for welding stainless steels and light metals using argon-oxygen mixture and pure oxygen respectively as a shield, was demonstrated by a Bombay firm in Calcutta and Bombay. Almost simultaneously, a Calcutta firm demonstrated the Fusarc-$CO_2$ and the Lynx processes of British design. To bring the $CO_2$ process within the reach of the average shop, India will have to produce the necessary silicon-killed steel wire indigenously.

**Welding in Building Construction**

The first reported large-scale site-fabricated and welded workshop having a covered area of approximately 438,000 sq. ft. was built in Calcutta in 1953[3]. Around the same year, some outstanding steel frame building designed for shop-welding and site riveting or bolting were completed in Calcutta. Of these, the Telephone Exchange Building has nine floors in the main building. The majority of floor beams are compound beams and these were shop welded. Stools for supporting the floor beams were shop welded to the columns but top cleats were shop welded to the floor beams. The West Bengal Government Building having 13 floors which today stands proudly over Calcutta's centre locality, has all its compound columns, plated floor beams etc. shop welded. For resisting bending moment due to wind, deep and suitable wind brackets were shop welded to floor beams and these brackets were riveted at site to the columns. The approximate weight of steel used in this building is 2200 tons.

**Bridges**

In India, welding came to be used in bridges only a little before the second World War. The first bridge[3] where web members have welded battens and diaphragms is probably the Mortakka railway bridge on the Western Railway. This bridge consists of 14 spans of deck lattice type, having 196 ft. 2 in. centre of bearings. In 1953, a bridge consisting 6 spans of 150 ft. andone span of 137 ft. 6 in. lattice type girders was built over the river Langulia by the then-called Bengal-Nagpur Railway. This bridge was designed for shop welding and site riveting.

This first major project just completed is the 5600 ft. long bridge built over the river Ganges at Mokameh in Bihar, known as the Ganga Bridge Project[4]. Welding played an important part in the fabrication of the superstructure. The novel feature of design was the extensive use of welding in the construction of all floor-members—for railway, roadway and footway—and also in the construction of a few members of the main girders such as hangers, posts (except end posts and portals), brackets, etc. Besides these, a good many numbers of secondary members, e.g. laterals, connecting brackets, hand rails etc. were either partially welded and partially riveted or fully welded. The bridge consists of 14 main spans of 397 ft. centre to centre bearings, with approximately 63 ft. deep girders positioned 29 ft. apart. High tensilesteel conforming to B.S. 548 was used for riveted construction and mild steel conform- to B.S. 15 was used for riveting or welding. Approximately 4500 tons of welded steelwork went into the project. Submerged-arc welding was used in the shops and deep-penetration and rutile type indigenous electrodes were used at site. All welding was radiographically inspected by the Government Test House, Calcutta.

**Pipes and Penstocks**

Bombay's water supply has been nearly doubled recently by the laying of a new all-welded pipeline 57 miles long[5]. Most of the pipeline is of 8 ft. diameter. Shells up to 36 ft. long were shop welded using submerged arc and Fusarc processes. Site welding was done by local welders using all-position rutile type electrodes.

Reference has been made to the fabrication of penstocks at Jog Falls and Papanasam by a Bombay firm during the last world war. Under the Five Year Plans, several important hydro-electric projects were undertaken and completed, mostly with technical collaboration from foreign firms. Mention was made earlier of the several penstocks lines laid by a Norwegian firm in South India. A project which deserves special mention here is the Kundah Hydro-Electric Project in the Nilgiris where penstocks made from T-1 steel were site-welded by Canadian technicians[6]. Longitudinally welded pipes of approx. 10 ft. diameter and 1/2″ to 5/8″ thickness came all the way from Canada, but circumferential site welding with low hydrogen hightensile steel electrodes called for exacting conditions especially during the monsoon

season. No preheating or postheating was carried out. Portable electrically heated ovens were used on the site to keep the electrodes dry. Site welding was tested 100% radiographically. Penstocks at Bhakra in the Punjab which are still in the process of laying, are about 15 ft. in dia. Shop welding is done with submerged-arc and site welding is done with cellulosic electrodes. Local stress-relieving is done on site-welded joints exceeding 1.1/4" in thickness, using induction heating coils. The entire welding is executed and controlled by Indian personnel.

At Koyna Project in the Western Ghats, about 200 miles from Bombay, a Bombay firm is fabricating and laying penstocks in consultation with a Swiss firm. Shells are welded by automatic welding in one of the most modern shops in India situated in Poona. Site welding is carried out entirely by Indian welders using low-hydrogen iron powder electrodes of indigenous manufacture. The penstocks have to be laid in cut rock and call for a high degree of skill and endurance from the welders. The firm will shortly start work on penstocks at the Sharavati Project in Mysore State and on this project high tensile weldable steel will be used.

At Rihand Project in Bihar[7], the penstock line is of mild steel and 16 ft. in diameter and varying in thickness from 8/16" to 13/16". Double-Vee butt joints are being tested 100% radiographically. Shells of 20 ft. length are welded in the shop and tested hydrostatically for a water pressure of $\frac{40{,}000t}{D}$ p. s. i. where t is the thickness of the penstock liner and D is the diameter in inches. No stress-relief is necessary since the thicknesses are all below 1.1/4" which is the limit of thickness for the heat treatment. The total tonnage of steel in penstocks, supports, expansion joints and bulkheads is 1169.

**Railway Coaches**

The Integral Coach Factory at Perambur near Madras produces lightweight all-welded steel coaches in collaboration with a Swiss firm. Against the production target of 350 coaches a year, the factory produced 502 coaches during 1959–1960 employing about 7000 workers. A variety of welding processes[8] are in use here and these include : seam stitch welding for panels (Peco-Folien-Stumpfschweissung), semi-automatic submerged arc welding for bolsters and other heavy members, spot welding, and last but not least handwelding using rutile type and low-hydrogen iron powder electrodes. The factory has lately developed all-coil spring bogies with loads on the side bearers instead of on the centre pivot[9]. According to the reports from the International Railway Congress Association, these types of bogies have been reckoned to be better in riding and provide more comfort to the passengers. I.C.F. is also working on the plans to manufacture A.C. Electric Multiple Unit (EMU) stock required for the Railway Electrification Scheme in Calcutta area.

In addition, Hindustan Aircraft Limited, Bangalore, has commenced production of integral coaches in collaboration with a German firm, the target being 300 coaches a year. A structural firm in Calcutta also makes the same number of coaches.

**Locomotives**

Broad guage steam locomotives are being produced in railway-owned Chittaranjan Locomotive Works in West Bengal, and metre guage steam locomotives are being produced in the private sector in the steel town of Jamshedpur. At both these places, high quality welding is done. Fireboxes are manually welded using medium-heavy coated rutile type electrodes and these are tested 100% radiographically. In Chittaranjan Works, the electrode used is the Indian counterpart of a very popular German electrode (FINCORD of Oerlikon-Eisenberg) and it is reported that rejections are consistently below 0.5%. The same electrode is being used for turning out all-welded boilers for the locomotives in place of riveted boilers. These all-welded boilers have been made progressively in five stages, and are under close observation in service. Submerged-arc welding is used for welding thick bar frames. Electrical locomotives are also being taken up for manufacture and these also involve considerable hand-welding.

**Wagons**

There are over a dozen firms in the private sector producing wagons for the Indian Railways. The common 'CR' type wagon is of riveted design, but the lately-introduced mineral-carrying wagon for steel plants, type BOX, involves considerable welding. The bogies are all-welded. These involve joining of Railway Class IV steel (carbon 0.4%) to mild steel and for this purpose a medium-tensile steel low-hydrogen electrode is used. A couple of firms in Calcutta use fire-cracker process (EHV-Schweissung) for making 2 m. long fillet welds in the reinforcing cross bars used on these wagons.

**Welding of rail joints[10]**

Welding of rail joints (90 lb-rails for the broad gauge) is being used increasingly on the Indian Railways. Two flash-butt welders of British make have been in operation for well over 15 years at Rosa on the Northern Railway and at Kalyan near Bombay. In addition, thermit-welding is used at

site. Thermit mixtures and equipment are supplied by a Kanpur firm which works in collaboration with a leading German firm. Rails are being welded in panels not exceeding 210 ft. (5 rail lengths). Tup test, which in the case of 90-lb. rail, consists of dropping a weight of 5 cwt. from a height of 12 ft. is carried out once for every 25 joints welded. Fatigue tests are also carried out under a rolling load on a fatigue testing machine. After $2x10^6$ reversals, the breaking load should not be less than 15 tons for the welded joint in 90 lb. rails. Results have shown that flash-butt welding is definitely superior to thermit welding as seen in the following figures.

| Type of Joint | Strength ratio – Joint/rail | |
|---|---|---|
| | Fatigue test | Tup Test |
| Flash-butt | Nearly 100% | 33 % |
| Thermit | 40 - 75% | 12.1/2% |

**Welding in Shipbuilding**

An extensive shipbuilding industry can give big fillip to welding as in the case of Britain and Japan. In spite of possessing an extensive coastline, India can boast of only one shipbuilding yard at Visakhapatnam on the east coast. This yard produces on an average 4 ships a year—each a 9000-tonner - which are 85% welded. Each ship requires approximately 25 million pieces of electrodes. Light-coated rutile type electrodes approved by Lloyd's Register are used mostly, except that iron powder deep penetration electrodes are used to some extent on the deckplates. Fusarc automatic welding is used in the shop. There are also many ship-repairing firms which also produce small ship and barges in Bombay and Calcutta.

**Welding Personnel & Training in welding**

A significant step in systematic training in welding was taken in 1957 by the Indian Standards Institution by publishing a Code of Practice for the Training and Testing of Metallic Arc Welders which recommends certification of welders also. Training has been conducted for the last few years by a leading Calcutta firm in Calcutta and Bombay and by a leading Bombay firm in Bombay. Several Polytechnics have sprung up in Indian cities and district places which give apprentice training in various trades including welding. Some of the big projects such as the Integral Coach Factory near Madras, Heavy Electricals Limited in Bhopal, Tata Iron & Steel Company Limited in Jamshedpur, Chittaranjan Locomotive Works in Chittaranjan, Hindustan Steel Limited in Bhilai, Rourkela and Durgapur etc. have their own schemes to train welding apprentices. The Government Test House in Calcutta has started testing welders from industry and issuing certificates both for general construction work and for boiler work. The Standards Institution has also prepared a handbook for welders which is under print. It is also planning to prepare a handbook for welding supervisors and welding inspectors.

**The Future**

The importance of welding and the increasing role it will play in the country's industrial development and technical progress have been recognised in all quarters in India. Several technicians have been going to Britain and Germany to get advanced training in welding under the Colombo Plan and the Indo-German Technical Co-operation. This year the National Productivity Council will be sending a six-man productivity team on welding to Japan, U.S.A. and a few European countries to study welding industries there and make recommendation to the Indian Welding Industry. Last year, the UNESCO sent out a welding expert from West Germany to organise a welding course in a technological institute in Bombay. This expert conducted two refresher courses in Bombay, one in Calcutta and a series of lectures in Delhi. His post has now been taken over by a welding engineer from Czechoslovakia.

A national welding society plays a significant role in every country in advancing and popularising the science of welding. So far an Indian Branch of the Institute of Welding, London, has been operating in Calcutta and all that it is able to do is to organise a few technical papers in Calcutta. Lately, a few enthusiasts have been drawing up plans to form an Indian Welding Society and later to secure membership of the International Institute of Welding.

Research in welding is essential for standardisation, and for progress. It should be conducted systematically and should be made to solve the industry's problems. A national welding journal which serves as a means of exchanging experiences and information and which permits the Overseas welding world to know what is going on in the country is also necessary. India lacks these, and therefore progress is bound to be slow. Need for these is recognised by those concerned directly with welding and it is hoped that in a few years Indian welding industry will grow in stature and experience.

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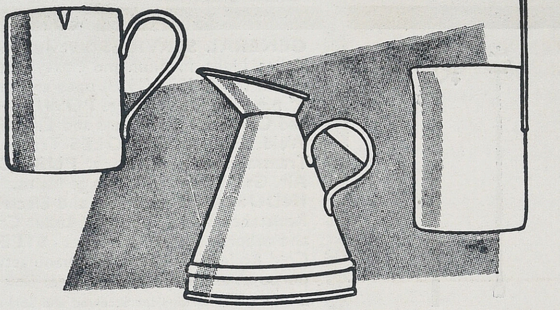

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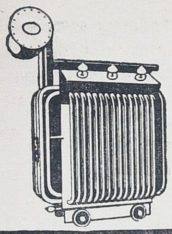

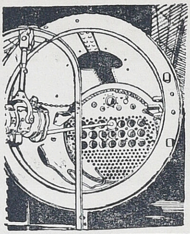

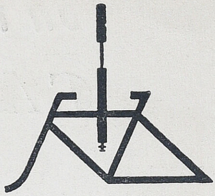

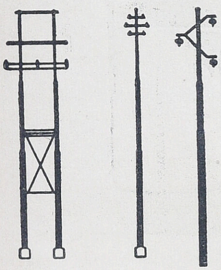

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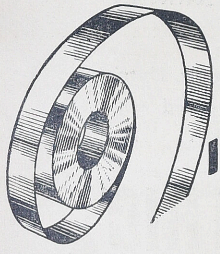

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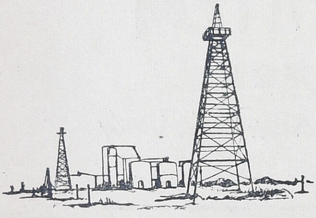

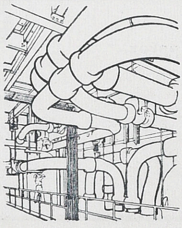

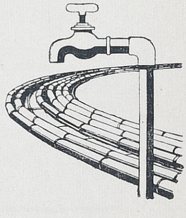

# Oxygen in Industry

S. V. SAMBAMURTI
Indian Oxygen Ltd., Calcutta

## Introduction

The oxygen industry has come a long way since the early days when oxygen was produced almost exclusively by the decomposition of the chlorate of potash and distribution was done in gas bags very similar to the bellows used by blacksmiths. Commercialising the process of oxygen production was first done by two brothers, Leon and Arthur Brin and the Brin's Oxygen Co. was founded in 1886. An output of 1,42,116 cu. ft. of oxygen was achieved at the end of the first year. Since the principal use of oxygen at that time was with coal gas and hydrogen to produce "Lime Light" for optical and stage lanterns there was difficulty in finding enough outlets even for this modest output.

The original gas bag did not last long and was soon superseded by steel cylinders. Today enormous quantities of oxygen are manufactured and distributed in both liquid and gaseous forms and oxygen consumption is measured by the ton (approximately 26,000 cu. ft.). Oxygen plants are in operation day and night all over the world producing thousands of tons of oxygen per day.

The figures given in table for production of oxygen in India during the two Five Year Plan periods reflect the rising trends in the country's industrialisation and use of oxygen.

**Table I**

Production of Industrial Oxygen during the period 1951-1961

| | In millions of Cubic Feet |
|---|---|
| 1951—1952 | 146.20 |
| 1952—1953 | 164.57 |
| 1953—1954 | 190.70 |
| 1954—1955 | 236.26 |
| 1955—1956 | 277.58 |
| 1956—1957 | 407.54 |
| 1957—1958 | 427.66 |
| 1958—1959 | 513.48 |
| 1959—1960 | 605.30 |
| 1960—1961 (Estimated) | 759.27 |

The principal applications of oxygen in present day industry are (a) for the oxyfuel gas flame (b) for the cutting of metals (c) for the refining of iron and steel and (d) as an explosive for blasting, not to mention its uses as an oxidant in rocketry and as a life saver in emergencies.

**The Oxy-fuel Gas Flame**

By far the most important property of oxygen that is made use of in industry is that it is a supporter of combustion. Of the various oxy-fuel gas flames in use in general industry, the most popular is the oxy-acetylene flame. With oxygen, acetylene (chemical symbol $C_2\ H_2$) gives a higher flame temperature (3200°C approx) than any other gas commercially produced.

The rate of combustion is very rapid. The intense heat produced is very localised and there is comparatively less dissipation of heat in the outer envelope of the flame. These properties make the oxy-acetylene flame eminently suitable for welding of metals and alloys. This flame has proved most versatile in that it can tackle most of the metals and alloys known to industry. It has its uses in the smallest garage as well as in the largest engineering workshop.

Apart from welding there are a number of other applications which can make use of this intensely hot source of heat. Flame hardening of steel surfaces for better resistance to wear is a typical instance. This process requires the raising of the temperature of a thin layer on the surface of the component to above the upper critical temperature for the material in the shortest possible time. The flame descaling process, the modern way of removing rust and scales from steel work, again depends for its success on the capacity of the oxy-acetylene flame to heat the scales only in such a short time that the parent material remains unaffected.

The metal spraying process in most cases utilises the oxy-acetylene flame for melting the metal wire or powder prior to spraying it on to the surface required to be metallised.

The oxy-acetylene flame is also commonly employed for pre-heat in oxygen cutting operations.

Other fuel gasses in use with oxygen, to a lesser degree of course, are the oxyhydrogen flame and the oxy-coal gas flame which are in use to a limited degree for specialised applications. For instance, the oxy-hydrogen flame is used as the pre-heat flame in underwater cutting of steel since acetylene cannot be used beyond certain depths. The oxy-butane and oxy-propane flames are, however, in more common use for general heating purposes, since the heat distribution in the flame is comparatively uniform, a requirement for such applications.

**Oxygen for Metal Cutting**

The oxygen cutting process is now so firmly established as an enineering operation that no workshop worth the name can do without it. This process is based on the fact that iron will burn when it is raised to a sufficiently high temperature for combustion to start, and fed with sufficient oxygen. The sequence of operation consists of raising the steel locally to a temperature at which ignition can start by the use of a suitable pre-heating flame and applying a jet of high purity oxygen of the correct volume and velocity as the cutter traverses the line of cutting. The iron under these conditions is converted to its oxides and the scouring action of the high velocity oxygen stream on the sides of the cut blows out these oxides. The chemical reaction being exothermic, the heat energy liberated hastens the process. Since successful cutting by oxygen is governed by the considerations that the metal must be capable of oxidation at a temperature below its melting point and the oxide produced must be fusable at a temperature below the melting point of the metal, the process is used mainly for the cutting of carbon and low alloy steels. With certain modifications oxygen cutting has been used for cutting other materials also, such as stainless steel, cast iron and even some of the non-ferrous metals. The difficulty in cutting these materials by normal oxygen cutting is due to refractory oxides or high rates of heat dissipation or layers of graphite as in the case of cast iron. Addition of iron in the form of a fine powder into the combustion zone increases the amount of heat available so that cutting can proceed smoothly.

Manual cutting torches of various types and capacities are being used everyday by structural and engineering workshops and in the scrapping and demolishing business. The steel works use the oxygen deseaming process for scarfing the surfaces of steel slabs. The oxygen lance provides a convenient method of piercing holes in iron and steel and of severing heavy sections of steel of difficult shape or in awkward conditions.

An interesting and spectacular application of oxygen cutting is underwater cutting used for structural and constructional work, bridges, dams, harbours and jetties as well as repair work on ships.

With recent developments in the field of mechanised oxygen cutting the engineer has been provided with a new precision tool for cutting and shaping material. A wide variety of shapes can be cut to such a degree of accuracy that for most purposes subsequent machining is unnecessary. Machines are available either manual or motor driven, semi or fully automatic, portable or stationary, which cut almost any size, shape or thickness.

Mention must be made of some of the special purpose cutting machines made to meet specific requirements of industry. For simultaneous preparing of all the four edges of rectangular plates on a

production basis oxyplane machines have been designed. A special machine to prepare ends of branch pipes without the use of templates or marking has been recently put on the market. Computer control for profiling machines has been tried out with success in shipyards in the U.K. By eliminating the laborious and time consuming process of making of plates prior to cutting and by drastically reducing the manpower necessary for the operation, it has given these shipyards the benefits of automation in this field.

**Oxygen in Iron and Steel Making**

Since the discovery of iron, the element oxygen has been of paramount importance in the metallurgy of extraction and refinement.

The iron and steel industry has always been using diluted oxygen in the form of air. Since this was the cheapest way of getting the oxygen, the presence of four times as much nitrogen was accepted. Use of air limits the temperature of combustion, the nitrogen acting as a space filler and causing much of heat loss. But the steel industry has from its beginning adapted itself to this and only recently has the reduction or exclusion of nitrogen in furnaces received much study. The reason for this growing interest in the use of oxygen in iron and steel-making processes is that with continued demand for higher output of quality steel, methods of maintaining or increasing production without heavy capital outlay are constantly being sought.

During the last few years, the technical and economic problems of making oxygen in the bulk quantities required for this application have been largely overcome and the process has been applied to iron and steel metallurgy on a wide basis.

The use of the oxygen-enriched blast in the Bessemer converter has made it possible to produce steel equal in deep drawing properties to highest open hearth standards. Another process now widely practised is the introduction of oxygen into iron or steel melts to give rapid removal of the metalloids. In this category fall the desiliconisicg process as carried out in ladles or mixers and the use of oxygen for carbon removal in the open hearth or electric furnace. The injection of oxygen on the melt surface in a converter to give steel as in the Linz Donawitz process has come into use in this country recently.

By reason of the increased thermal efficiency which can be obtained using oxygen enrichment of the combustion air, the melt-down period for scrap can be reduced appreciably in certain circumstances.

The future points to even greater uses of oxygen in all operations that are now accepted by the iron and steel industry and it is very likely that logarithmic curves may have to be used in the near future for plotting the rise in production of oxygen all over the world.

**Oxygen for blasting**

Oxygen in its liquid form is being widely used for blasting operations in open cast mining and quarrying. The process popularly known as L.O.X. (for Liquid Oxygen Explosives) has been generally accepted for such applications on account of the advantages it has over other explosives in respect of economy, safety and efficiency.

The process consists of impregnating a specially made cartridge which has as its principal ingredient a cellulosic substance, by soaking it in liquid oxygen and detonating it by suitable means at the desired location. It will be seen that the process does not use a ready made explosive with its inherent hazards. Neither liquid oxygen nor the cartridge is explosive by itself and the nature of the process allows it to be ensured that explosive conditions exist only for a short period-just at the time required. The safety that this process offers in storage, handling and use is a very important factor in its favour in applications under conditions such as exist in mining or quarrying operations. No poisonous fumes are produced and in the case of misfires all that has to be done is to wait till all the oxygen has evaporated from the cartridge.

By careful control of the ingredients of the cartridge, it is possible to vary the violence and rate of detonation to suit any particular condition that is met with. The process is flexible in that cartridges are available to produce explosives having a prominent heaving property as required in the case of coal, bauxite and gypsum or alternatively having the high shattering strength needed for blasting tough rocks such as granitic gneiss.

While primarily intended for the mining industry, the process has sometimes been put in use also in other fields where controlled blasting is required. An instance is the blasting of larger size iron and steel scrap to break them up to sizes suitable for the remelting furnace.

**Oxygen in Rocketry**

The major 'breakthrough' in the sphere of space travel that the world has witnessed in the recent past is the result of the painstaking work done on the subject of rocket propulsion by scientists and technicians. The tremendous power that is required to lift satellites weighing thousands of

pounds and put them in orbit is generated by combustion reactions using very large quantities of oxygen at rapid rates for burning the fuel. Oxygen in the form of liquid is invariably used as the oxidant in the case of rockets and missiles such as the ICBM.

**Oxygen Saves Lives**

Industry has recognised that a very important factor in achieving efficient productivity is the welfare of the men work the machines. Many of the major employers have extended hospital and other medical facilities to their men and their families. Oxygen has an important place here also, assisting the physician and surgeon in resuscitation of patients in the case of accidents and other conditions involving respiratory emergencies.

**Conclusion**

It may be expected that the use of oxygen in India's industry will grow very rapidly in the near future. The following table which gives a summary of the estimated demand for oxygen for all purposes at the end of the third and fourth plans makes interesting reading. The figures given are in million cubic feet, rounded.

**Table II**

| Year | *Welding & Cutting* (excluding steel Plants) | | *Steel Plants* Steel *Making* | General *Purpose* | *L.O.X.* | *Total* |
|---|---|---|---|---|---|---|
| 1960—61 | 550 | Private Sector | 180 | 150 | 120 | 1,000 |
| 1965—66 | 1,400 | Private Sector | 1,000 | 250 | 300 | 2,950 |
| | | Public Sector | 6,500 | 800 | | 7,300 |
| | | | | | | 10,250 |
| 1970—71 | 3,250 | Private Sector | 4,000 | 450 (4.5x100) | 750 | 8,450 |
| | | Public Sector | 15,000 | 1,500 | | 16,500 |
| | | | | | | 24,950 |

The author wishes to extend his thanks to the management of Indian Oxygen Ltd., for making possible preparation of this article and for permission for its publication.

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# The Heavy Electricals The Project and the Prospects

S. SARANGAPANY

Managing Director, Heavy Electricals Ltd, Bhopal

Availability of cheap electric power is now universally recognised as the key to industrial development. The Second Five Year Plan with its emphasis on rapid industrialization has a substantial provision for new generating units and as the equipment for generation of electricity of any magnitude is now almost wholly imported from abroad, the setting up of a heavy electrical factory designed to achieve self-sufficiency in the production of such equipment became an essential feature of the Second Plan. The Bhopal project had to face heavy weather almost at its inception as our foreign exchange reserves were dwindling at an alarming rate early in 1957, and it was impossible to think of a new industry, so heavily dependant on imported equipment, without advance arrangements for making sufficient foreign exchange available. The Project Report submitted by the British Consultants, who had been appointed technical consultants to the project in 1955, pointed to an investment of nearly Rs. 17½ crores on imports against a total outlay of Rs. 38½ crores. A period of nine months elapsed after the Government had accepted the report in principle before an agreement could be reached with our Consultants and a consortium of British bankers for a modest sterling credit of about Rs. 4 crores. The work had consequently to be executed in stages, and a truncated project called the first phase estimated to cost approximately Rs. 21.47 crores was initially sanctioned late in December 1957. The requirements of heavy electrical equipment annually was estimated at Rs. 12.5 crores and the project estimate had provided for this target to be achieved in 1968, to be followed by a further increase to Rs. 22 crores by 1980. Phase I as sanctioned could only provide for an annual output of Rs. 6.25 crores.

Hardly had the project gone into active field work, when Government decided to restore the cut caused by the division into three phases. The project had never had to look back ever since. Preliminary sanctions for taking up phases II and III were accorded in May 1959. By now, the figures of imports of heavy electrical equipment during the three years 1956 to 1958 amounting to over Rs. 80 crores had come under study, and it was realised that the requirements of heavy electrical equipments during the Fourth Plan might well reach a figure of nearly Rs. 100 crores per annum. By the middle of 1959, Government had decided in principle to double the capacity of the Bhopal plant so as to produce Rs. 25

crores worth of electrical equipment annually. As this was a bare quarter of the eventual requirements during the Fourth Plan, the problem of further expansion came under active consideration, and early in 1960 Government took a decision to further increase the capacity of the factory at Bhopal so as to provide for an annual output of approximately Rs. 50 crores and to build two other heavy electrical projects, one in the North and one in the South of country, with an initial production capacity of approximately Rs. 15 crores each. These two factories are to be put up with Russian and Czechoslovakian collaboration respectively.

**Complete Rethinking**

The proposal to increase the annual output at Bhopal to Rs. 50 crores meant a complete rethinking. Thanks to the prompt response of our Consultants, the production programme, which under the original project report of 1956 required 14 years for achieving an annual production of Rs. 22 crores, has now been revised to give an annual output of over Rs. 25 crores in 5 years i.e., by 1965, and Rs. 50 crores by 1968. This is a four-fold increase, compared to what was contemplated in the original report.

It is interesting to examine the implications of this increased output on the capital structure of the project. The capital cost of the factory for an annual output of Rs. 6.25 crores was estimated at Rs. 21.47 crores. For quadrupling the production, the capital cost increased to Rs. 38.47 crores, which is less than double the former figure. Doubling the output again to Rs. 50 crores per annum involves a capital expenditure of slightly under Rs. 60 crores. The ratio of capital investment to annual production (excluding working capital in all cases) thus shows a welcome drop from 3.4 to 1.2. Adding the cost of working capital, estimated at Rs. 37.50 crores for an annual output of Rs. 50 crores, the capital invested by 1968 would be of the order of Rs. 97.50 crores. This is exclusive of the cost of the township, which for the immediate present will be limited to Rs. 9 crores for housing 7,000 staffs and 3,000 trainees. An annual production of Rs. 50 crores will entail the employment of 35,000 workers.

The expansion of output to Rs. 25 crores, which is the present sanctioned figure, has necessitated a reappraisal of the size of individual units to be manufactured in this factory, and it has now been decided that targets for the size of individual units should be immediately increased. Turbo-alternators originally limited to 50 mega watt units will now be built upto 150 mega watts. Transformers originally limited to 55 MVA will now be built upto 150 MVA. The size of the factory blocks will in fact permit further increase in the size of transformers to the maximum employed anywhere in the world, which is approximately 400 MVA.

**Tempo Accelerated**

Considering the substantial capital investment and the huge saving in foreign exchange which this industry will usher, it was decided at the very beginning to accelerate the tempo of construction work so as to make good at least a part of the delay caused in sanctioning construction work. The efforts of the engineers have met with considerable success, despite a multitude of problems not the least of which was the acute scarcity of steel. It is gratifying to record that production was commenced on the original scheduled date, viz., lst July, 1960 with the manufacture of switchgear and transformers. Against a factory floor area of 5,96,000 sq. ft. targeted for completion by June'61, we have already provided 6,97,000 sq. ft. Block III (for transformers & Capacitors), Block IV (for switchgear and control gear) and Block V, (Foundry) are complete and foundations for Block I (water turbines and heavy fabrication), and Block II (rotating machines) should be ready by beginning of 1962 for the installation of machines. Common services such as 3000 KW. power house, technical services laboratory, 'Blue-water' gas plant etc., are available.

All machine tools received upto date have been erected and commissioned. Test equipments for Switchgear and transformer testing are ready for service. The first unit of 11 kv Switchgear, as also the first transformer, are expected to leave the production lines by July'61. The year 1962 will see the production at Bhopal of air-blast circuit breakers for 132 kv and power transformers upto 40 MVA. The same year will also see the production of traction motors and other equipment for railway electrification, both for the DC system in the Bombay

area and the AC system in the eastern area. Work will also be commenced on water turbines and water turbine driven generators of a rated capacity of 32 mega watts. By 1963, production will comprise air-blast circuit breakers for the highest voltages and rupturing capacities required, power transformers upto 60 MVA and water turbines and water turbine driven generators of the biggest size required in the country, besides diesel engine generators, large industrial motors upto 5,000 HP and motor control gear.

The 6th of November 1960 unfolded a glorious chapter in the history of the Heavy Electrical Project; on this day, less than two years after the foundation stone was well and truly laid by Shri Lal Bahadur Shastri, the Union Minister for Commerce and Industry, the completed first phase of the factory was inaugurated by our beloved Prime Minister. In dedicating this Rs. 100 crore project to the nation, we of the Heavy Electricals, Bhopal, while taking a legitimate pride on the successful completion of the first task allotted to us, are resolved to spare no pains in ensuring the quality of our products, so that not only our country but our British collaborators also will have every reason to be proud of this enterprise.

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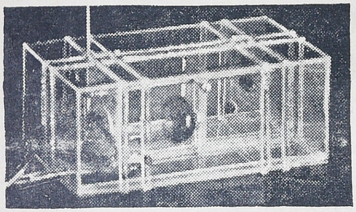

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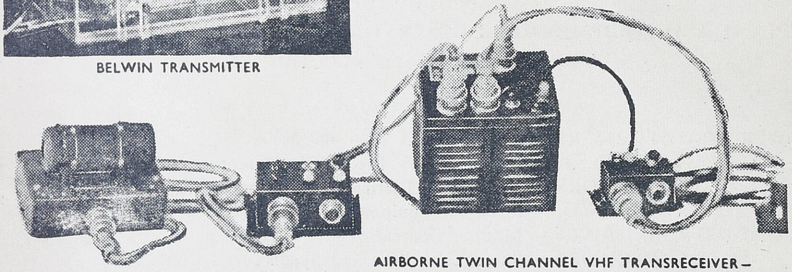

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# Central Electronics Engineering Research Institute

The Central Electronics Engineering Research Institute came into being with the laying of its foundation stone by Prime Minister Jawaharlal Nehru on the 21st September, 1953. The primary motive forces behind the idea were the foresight and dynamism of the late Dr. S. S. Bhatnagar and the munificence of Shri G. D. Birla, who offered to donate Rs. 21 lakhs on behalf of the Birla Education Trust.

The construction work of the Institute was started in September 1954 and completed by October, 1956. Much of the success of the undertaking during those two years was due to the perseverence and labour of the then Planning officer, Dr. N. B. Bhatt and to the constant support and wise guidance of Prof. M. S. Thacker, the Director General of the Council of Scientific & Industrial Research.

Dr. B. H. Wadia was appointed as Assistant Director-in-Charge with effect from 1st April, 1957. Dr. Amarjit Singh succeeded Dr. Wadia as Assistant Director-in Charge with effect from 15th April, 1959.

The basic electronic equipment amounting to Rs. 15 lakhs worth of well-chosen equipment was in the main provided through the Technical Cooperation Administration of the United States Government. These equipments were further supplemented by purchase from the Institute funds. The essential equipment and facilities were commissioned by the beginning of 1958, and work on scientific projects got started.

**Objectives of the Institute**

It is known that the radio industry in India has made commendable progress in radio receivers and public address systems. However, many of the more recent and important fields of electronics are still untouched. It is the objective of this Institute to clear the path for the industry to enter into some of these newer fields, which are so vital to a modern industrialised nation.

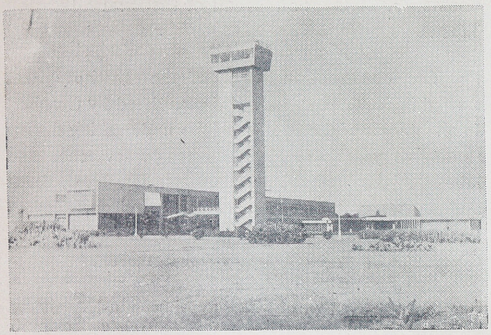
Work has already made headway in three of these fields, namely, (i) Special purpose electronic valves; (ii) Modern aspects of acoustics; and (iii) Electronic instrumentation. The fields of Special Communication System and Electronic devices of the Transistor family will be taken up in the near future.

The salient features of the scientific work are as follows :

## BRIEF RESUME OF TECHNICAL PROJECTS

### 1. Electronic Valves

Most people are familiar with the small valves that are used in radio receivers. However, electronic



*Central Electronics Engineering Research Institute, Pilani*

valves extend over a very much wider range than that covered by these small familiar ones. For instance, there are large transmitting valves used in industry and in broadcasting stations; there are special valves which are essential in radar, in television and so on. These categories of valves are characterised by considerable complexity in structure, highly sophisticated techniques of fabrication, and a resultant high cost per unit. Since the fabrication of receiving type valves is done on a large scale and has already been taken up by Bharat Electronics, this Institute is concentrating its activities on the special purpose valves. Besides developing know-how in a critical field, a considerable saving in foreign exchange can be effected by making some of these valves indigenously.

The items of equipments which are required for making such valves have been set up and the techniques have been developed. Magnetrons, which are used as transmitter valves in radar sets, have been fabricated and tested successfully. Their performance compares favourably with those of equivalent imported models. A wide tuning range magnetron of novel type is also being developed. A travelling wave tube, which is another type of valve used in radar sets on the receiver side, has been designed and is being fabricated. Work has also been started on high power transmitting valves.

### 2. Audio Engineering

High quality reproduction of speech and music is not possible without a highly fidelity microphone, and a well-designed auditorium or studio. Thus, among other things, the Audio Engineering Division has taken up projects on high quality microphones, and on acoustic treatment of studios and auditoria. In making the microphones, materials readily available within the country have been used as a starting point. Careful engineering design has been carried out for two types of microphones, namely, moving coil type, and condenser type. Thus, the performance compares favourably with many of the highpriced imported models. Jigs and tools for assembling the microphones, have been designed, and techniques have been set up for their calibration.

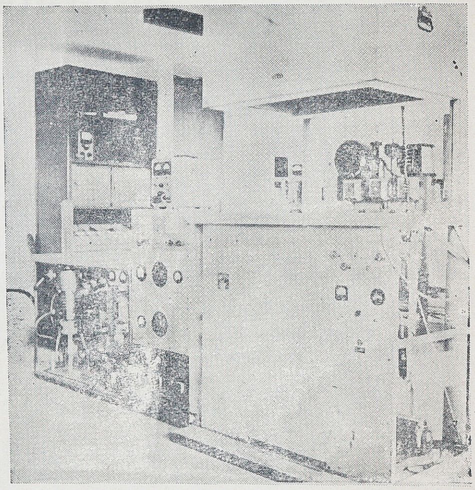
Measurements have been made on various indigenous materials for their sound absorption properties with a view to their utilisation in the design of auditoria. The Division has provided consultant service in the construction of two auditoria, whose acoustics have been found to come upto high standards. So also, consultant service has been provided in the reduction of noise in installations for testing aircraft engines.

Besides these two fields of activity, instruments are being developed for use in measurement of sound and noise, and for transmitting speech with the utmost 'economy' without sacrificing intelligibility.

### 3. Electronic Instrumentation

Electronic Instrumentation is playing an increasingly important role in not only the telecommunication industry, but also in several other industries. The use of such instruments extends from delicate sensing devices to complex systems controlling industrial processes and machine tools or carrying out computation at lightning speed.

In this Division, a radio frequency signal generator, which is extensively used by the radio industry,



*A part of the Vacuum Tube Laboratory*

has been designed and fabricated. Also a ran'om noise generator and a d.c. amplifier have been developed.

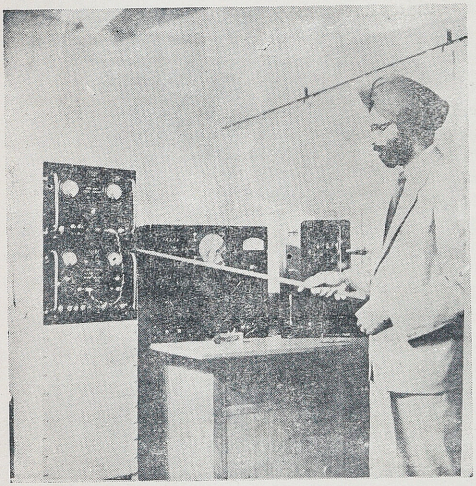
Many industrial and research establishments require electronic meters which automatically give a record of the variations of an electrical quantity. Work on the construction of these so-called "pen-recorders" has been started. Among metering instruments, "digital voltmeters" are assuming an increasing importance. As against the conventional meters which show the voltage in terms of the movements of a pointer needle, these digital voltmeters show the voltage as an actual number which can be read out either by the human eye or by an electronic calculator. Several sub-units of such voltmeters have already been developed.

Among the modern trends in electronic equipment is the use of "printed circuits", instead of the conventional wiring. This makes it possible to reproduce equipment on a mass production basis and also to reduce the size of the instrument. Such printed circuits have been developed for the signal generator mentioned earlier under this heading.

**Auxiliary Facilities**

A precision Workshop with facilities for turning, milling, shaping, welding, sheet-metal work, electroplating and carpentary work etc., has been set up. The workshop has been providing essential support to the research work by providing components, jigs and various items of equipment for the scientific projects.

Up-to-date information about research work going on in other parts of the world and in this country is important for making the most effective use of the resources of the Institute. To this end a



*Electronic Instruments developed at the Institute*

Committee selects books and publications for the Library which now contains 2755 books on electronics and associated subjects. Also 105 current journals are being received. In addition to these publications, special reports from research libraries abroad are also obtained.

**General Activities**

The Institute has its own housing colony in which 90 quarters have already been completed for various categories of staff. 28 more are under construction. The Colony has a Club, which organizes sports activities, cultural activities, film shows, etc. for the recreation of the staff and their families. A Cooperative Store, run by volunteers from the Institute staff, provides some of the day-to-day requirements of the residents of the Colony. The Colony has well laid-out parks and play-grounds for children. Very shortly, a Club House-cum-Guest House-cum-Hostel will be added to the amenities of the Colony.

It may be mentioned that through the enlightened guidance and the dedicated service that the Institute has received, it has established research at Pilani, on some of the most modern lines. Some of the projects that had been started, have already yielded fruit and others are almost complete. The results achieved have excited considerable interest among the users in the industry, Government departments, etc. In the future too, one may look forward to a steadily increasing contribution from the Institute to the development of electronics in the country.

* * *

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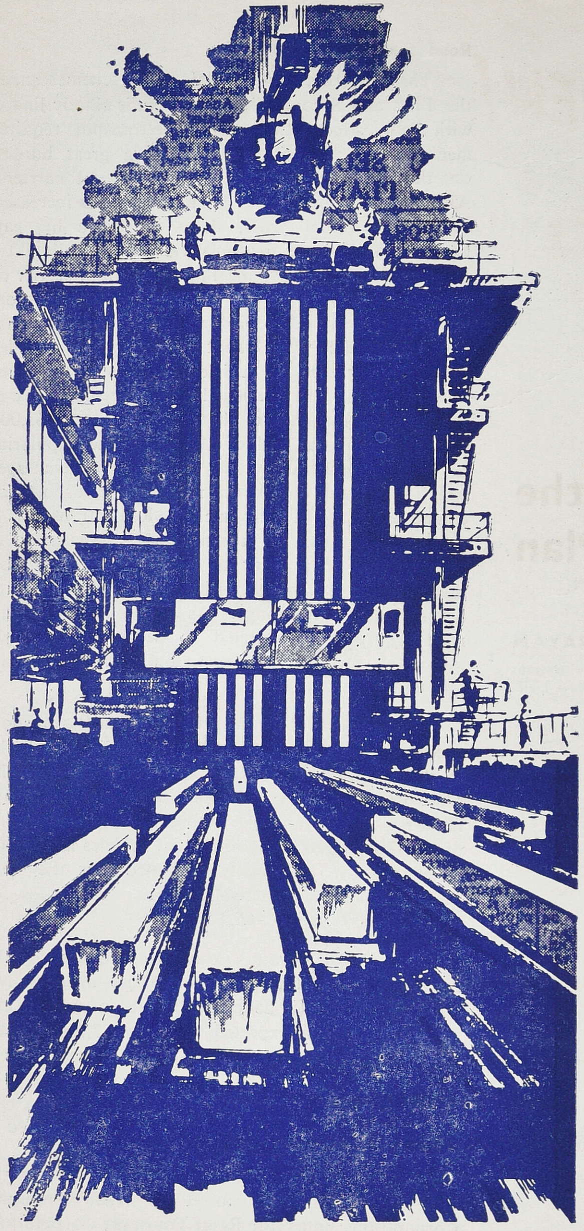

# INDUSTRIES SECTION

# Transport in the Third Plan

Dr. P. SUBBARAYAN
Minister of Transport & Communications
New Delhi

**Road Transport**

The execution of the development schemes under the First and Second Five Year Plan is closely linked with the question of transport. The transport requirements of the country have thrown a great burden on the Railways. which are the biggest carriers. Although the capacity of the Railways has increased during the recent years, there is still a big gap between the demand for transport and its availability. Next to the Railways, the most important carrier of men and materials in this country is road transport which has been developing rapidly during the last decade. There were about 83,000 goods vehicles and 34,000 passenger vehicles in India at the commencement of the First Plan. This number was expected to increase to about 1,80,000 and 65,000 respectively by the end of 1960–61. The popularity of road transport is due to the inherent advantages which it enjoys over other modes of transport for certain category of movement. Road transport is preferred for moving commodities because it is quicker and offers door to door delivery. It also does not involve any transhipment and there are fewer chances of pilferage. As our economy expands, road transport is expected to become increasingly important for the transportation of few materials and finished products.

As in the Second Plan, road transport programmes in the Third Plan also will largely be in the private sector. The expansion of commercial road transport will be conditioned by the manufacturing capacity of the automobile industry. The production targets for commercial vehicles in 1965–66 is 60,000. It is roughly estimated that the total number of the commercial vehicles will increase to about 3,65,000 in 1965–66.

For the expansion programmes of the nationalised road transport undertakings in the States, a provision of Rs. 25 crores has been made in the Third Plan. It is expected that about 7,500 vehicles will be added to the fleets of the nationalised undertakings during the Plan. The share of the nationalised undertakings in the total passenger services by road is expected to remain unchanged at the existing level of 30 per cent. As far back as 1954, the State Governments were advised by the Planning Commission to set up Road Transport Corporations under the Road Transport Corporations Act, 1950, for the management of the nationalised

road transport undertakings in which the Railways, and if possible, the private operators should participate. The object of this policy decision is to ensure that these undertakings follow commercial principles and practices. Since the Railways are to participate as shareholders in these Corportions, proper coordination between rail and road transport services will also be possible. Road Transport Corporations have already been set up in some States and efforts are being made to persuade the remaining States to fall in line with the policy of the Central Government in this respect. Provision has also been made in the Railway Plan for the Railways to contribute their share to the expansion programme of the Nationalised road transport undertakings in the States.

Questions relating to coordination between the various forms of transportation, particularly rail and road, have been engaging the attention of the Government of India for some time. It was felt that a comprehensive examination of these problems would be of considerable interest for future planning. Accordingly, the Government of India set up a high-level Committee in July, 1959, under the Chairmanship of Shri K. C. Neogy, to study the various problems involved and to suggest the lines on which the national transportation policy should be formulated. The Committee submitted its preliminary report to the Planning Commission in February 1961. This report attempts mainly to present a detailed analysis of the present situation and to formulate the main issues "thrown up" as a result of the studies undertaken by the Committee. According to the Committee, a study of the experience of the foreign countries shows that there are broadly three ways of securing coordinated development of road and rail transport on equal terms. Firstly, there is the possibility of allowing free unrestricted competition between different modes of transport. Secondly, the necessary coordination may be achieved through appropriate Government regulation. The third alternative is of the road and rail services to be integrated into one unit. Although, at first sight. it may seem that in Indian conditions only the second alternative has any relavance in the immediate future, the Committee is of the view that it would be wrong to dismiss summarily the other two alternatives. Our transport system has to develop a great deal during the next 10 years, if it is to keep pace with the programmes of industrial development on which we have embarked. To rely on regulatory measures, to be devised ad hoc as and when any signs of unhealthy competition appear, will not, in the view of the Committee be the right answer to the problems facing the country in this field.

**Road Developments**

The main objectives of road programme of both the Central and State Governments are :

(1) Easy access to all villages :

(2) Opening up of new areas and developing undeveloped and underdeveloped areas :

(3) Improvement of roads and bridges to cope with the increasing volume of traffic and the head load of modern vehicles.

Rapid strides have been made in road development in the country during the last decade, but considerable leeway yet remains to be made.

Expenditure aggregating over Rs. 300 crores is estimated to have been incurred on road development in the country under both the Central and State Sectors since the commencement of the First Five Year Plan and as a result nearly 1,49,000 miles of roads made up of 46,000 miles of surfaced roads and 1,03,000 miles of unsurfaced roads are estimated to have been added to the road network of the country in that period. The total length of surfaced and unsurfaced roads at the end of the Second Five Year Plan period is estimated to be of the order of 1,44,000 miles and over 2,50,000 miles respectively.

According to the present allocations, a sum of Rs. 264 crores has been provided for roads in the Third Five Year Plan out of which a sum of Rs. 50 crores is for National Highways and roads in Sikkim and the balance of Rs. 214 crores is for roads other than National Highways under the Third Five Year Plans of States and Union Territories. Nearly 25,000 miles of surfaced roads are expected to be added to the road system during the Third Plan period.

Constitutionally, the Government of India are primarily responsible for roads declared as National Highways. All roads other than National Highways are essentially the responsibility of the State Governments concerned. Substantial grants are, however, given by the Government of India to State Governments to assist them in their road development programmes.

At present, the National Highway Programme mainly aims at consolidating the existing system by constructing missing road links, bridging unbridged river crossings and improving low grade sections. The total length of roads included in the present National Highway System works out to about 14,880 miles. In order to complete this system, nearly 1,780 miles of missing road links and 150 major bridges were required to be constructed and about 10,000 miles of low grade sections improved. Nearly Rs. 77 crores are estimated to have been spent on the

development of National Highways upto the end of the Second Five Year Plan since 1—4—47 when the Government of India assumed financial responsibility for roads classified as National Highways. In physical terms, over 1,300 miles of missing road links and 73 major bridges were constructed; 8,400 miles of low grade sections improved and 2,300 miles of improved sections widened to two lane carriageway in that period. The work of consolidating the existing National Highway System will be continued in the Third Five Year Plan which includes a provision of about Rs. 48.50 crores for the development of National Highways. It is hoped to construct nearly 300 miles of missing road links and 47 major bridges with outlay in the Third Five Year Plan. Besides, some other works including the Vivekanand Bridge Bypass near Calcutta will also be undertaken in the Third Plan under the National Highway Programme.

Under the Road Programmes in the State Sector, special consideration is being given to road development in rural areas. Specific provisions have been set apart for this purpose in the plans of several States in addition to the provisions available for development of rural roads under the programmes of local bodies and Community Development. Further, as in the Second Plan, in deciding the provision for road programmes in the Third Plan, particular attention has been given to the needs of areas which are comparatively backward in regard to the means of communication. Thus in the plans of Andamans and Nicobar Islands, Himachal Pradesh, Manipur and Tripura about 1/4th to 1/3rd of the total outlay has been allocated for road development, Among the States in which road development has been given high priority mention may be made of Assam, Jammu and Kashmir, Madhya Pradesh and Rajasthan.

**Inland Water Transport**

I.W.T. used to play an important role in the communication system of the country till the middle of nineteenth century. With the development of Railways and the withdrawal of large volumes of water from the upper reaches of the rivers for purposes of irrigation, its importance declined. After partition, steps have been taken to encourage the development of I.W.T. where it has been found most suitable and useful.

During the last decade, a body known as the Ganga Brahamputra Water Transport Board was set up for ensuring the co-ordinated development of I.W.T. in the North East India. The Board has undetaken experimental Upper Ganga Pilot Project and Country Boat Towing project. A river port at Pandu is also under construction.

The Gokhale Committee, set up to examine all the aspects of the development of I.W.T. in the country desired that a provision of at least Rs. 50 crores should be made in the Third Five Year Plan to ensure some appreciable advance. The Planning commission have, however, agreed to the inclusion of schemes costing Rs. 6 crores only for I.W.T. in the Third Plan. It is proposed to develop water transport on Hijli, Ganga, Buckingham Canal, Orissa-Canal, West Coast Canals and Rajasthan Canal. Steps will also be taken for the improvement of I.W.T. on the rivers, Brahmaputra, Ganga, Rupnarain, Mahanadi, Tapti and Narbada.

**Sea Transport**

The tonnage on the Indian Register at the beginning of the First Plan was about 3,91,000 G.R.T., which rose to about 6,00,000 G.R.T. at the end of that plan, as, targetted. The target set for the Second plan was 9,00,000 G.R.T., which also was achieved, taking into account ships under construction in the Indian and foreign yards. For the plan, the target for shipping recommended by the National Shipping Board was 14.22 lakhs G.R.T. on a total outlay of Rs. 118 crores. The foreign exchange cost of the programme was estimated at about Rs. 104 crores. However, due to the limited resources, the Planning Commission have found it possible to allocate only Rs. 55 crores and the physical target envisaged is 11 lakhs G.R.T. Even at the outset, it has been made clear that virtually the entire foreign exchange needs of the industry have to be arranged for by obtaining foreign aid. It is our earnest hope to accomplish this take and if it actually becomes possible to tap greater foreign exchange resources, every effort will be made to find the matching rupee finance.

Another important problem that Indian shipping may have to face during the Third Plan period would be to capture a greater percentage of our foreign trade, so that there is full employment for the Indian ships. It is well known that the Indian ships, at present, do not carry even ten per cent of our foreign trade. Our shipping industry has, therefore, to make every effort not only to capture a greater percentage of our foreign trade but also to enter more and more new routes which are at present entirely served by foreign shipping lines. Then again, the whole of our overseas oil trade is at present carried in foreign tankers. It is proposed to acquire some ocean going tankers in the Third Plan period to make a beginning in carrying our overseas oil trades.

**Civil Air Transport**

The nationalisation of Air Transport industry was a landmark in the history of Civil Aviation in India. The Air Corporation Act which was passed in

1953, provided for the setting up of two Corporations—one for the operation of long distance international air service, and the other for domestic air services and services to neighbouring countries.

The two Corporations, viz. The Air India International and The Indian Airlines Corporation have been making steady progress since nationalisation. The Air India International started with a fleet of four constellations. In order to be able to compete with other powerful international operators in the field, it has been the policy of the A.I.I.C. to keep itself abreast of the latest developments in air transport. With this end in view, the Corporation acquired 10 Super Constellations and 4 Bœing 707 Jet air-craft during the 1st and 2nd Plan. They are exploring the possibilities of acquiring two more Bœings, due to be delivered early in 1962. With the acquisition of two additional Bœings, the Corporation hope to replace all their existing Super Constellation service by Bœings. The Corporation also propose to increase the frequencies of their services on existing routes e.g. the frequencies to U.K. and U.S.A. are proposed to be increased to Daily eventually.

The Air India International have a programme to set up during the Third Plan period their own workshops for the overhaul of their Jet engines.

The Indian Airlines Corporation purchased 10 Viscounts which are operating on their trunk routes in India and the routes to the neighbouring countries resulting in substantial increase in revenue. Two secondhand Viscounts are expected to be added to the fleet of the Corporation shortly. The Corporation are also exploring the possibility of acquiring 2 more second-hand Viscounts.

The Corporation have acquired 5 Fokker Friendship aircraft which were put into service during May, 1961 on the routes in the Eastern Region and on the Delhi-Agra Banaras-Calcutta route. The question of purchasing 5 more Friendships is under consideration.

The Corporation's plan for the development of their services during the Third Plan-period are based on the following traffic forecasts :

| Year (Third Plan Period) | Estimates of Passenger - miles required on Trunk Routes (in millions) | Estimates of Passenger miles required on Regional Routes (in millions) | Estimated total of passenger miles for the year (in millions) |
|---|---|---|---|
| 1961—62 | 318.702 | 117.781 | 436.483 |
| 1962—63 | 387.695 | 184.099 | 571.794 |
| 1963—64 | 470.254 | 198.827 | 669.081 |
| 1964—65 | 566.326 | 213.555 | 779.883 |
| 1965—66 | 675.950 | 228.283 | 904.233 |

In order to keep pace with the development in air transport, the Third Five Year Plan envisages interalia the augmentation of the ærodrome and communication facilities and modernisation of equipment at various Stations, in addition to the development of the international airports to make them suitable for jet aircraft operations and the construction of new ærodromes and gliderdromes.

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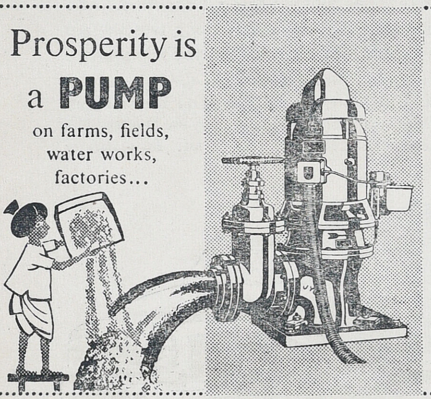

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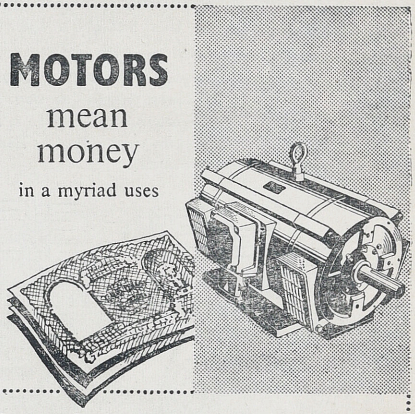

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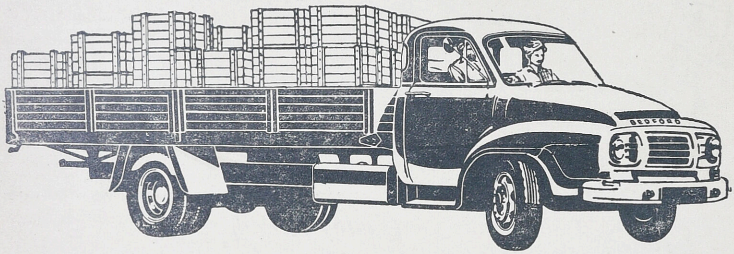


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# Air-India's Contribution to World's Air Transport

Commercial aviation is comparatively a newcomer to the world scene. Powered flight itself has only recently passed its first half-century. Yet few human activities are as complicated as the business of transporting men and goods by air on a regular schedule.

Few have had such an impact upon the world in their international application, expanded as rapidly and have had to face the necessity of persuading the world to make major changes in laws, habits and modes of thought in order to make possible the service they offer.

The airlines have been able to do all this only because international air travel is a well-knit global system touching millions of lives—a system in which pilots, radio operation control tower personnel and ticket salesman, wherever they may be, use the same procedures, talk to one another in the same terminology and language, pool the best of their knowledge and experience for the good and safety of the peoples of the world.

Before World War II, the number of airlines which had international operations could be counted on the fingers of one hand. Today, still within the active adult life span of some of the pioneers of 1919—the roster of the International Air Transport Association comprises 91 members airlines of which 80 operate on international routes. Their flights have dwarfed the mountains, diminished the plains, spanned the oceans, and made the world into a vast neighbourhood.

The post—war history of world air transport has been one of phenomenal growth. No other form of transport has made such progress in so short a time.

Scheduled civil air transport first came to India by an accident of history, when in the thirties the British, the French and the Dutch extended their Empire air service to and across India.

By a happy coincidence the beginnings of commercial aviation in India parallel that of the United States. Charles Lindberg's dramatic New York/Paris solo flight in 1927 opened the door to modern air transport in the new world. Three years later, on the other side of the world, J. R. D. Tata's spectacular solo flight from England to India gave fillip to commercial aviation in India.

Again, three years after the "Lindberg Line" was opened in the U.S.A., Tata Airlines inaugurated the first scheduled airmail service in India on 15th October 1932. The route was Karachi/Ahmedabad/Bombay.

*AIR-INDIA's Boeing 707-420 Intercontinental Jet powered by Rolls Royce Conway Engines*

In India as in the U.S.A., the transportation of mail by air was the mainstay of Indian Aviation in the early days. The surcharged mail carried by Tata Airlines—the only source of revenue—included a fairly good quantity of overseas airmail brought to India by Imperial Airways whose service connected at Karachi with Tata Airlines. For the first three years, mails used all the payload.

On the basis of a similar airmail contract with the Government of India, Indian National Airways Ltd. was set up in Delhi in 1933. Tata Airlines and Indian National Airways operated their services with light single-engined aircraft with little or no communication or navigational facilities.

Passengers in those days were looked upon as interlopers in the business of transporting mail. Government regulations enjoined that passengers and mail must be carried in separate compartments. It was difficult for Tata Airlines to make both ends meet. Only eight passengers flew Tata Airlines in its first year of operations.

**Empire Airmail Scheme**

It was not until 1938 that Tatas saw the beginning of prosperity. Heavy loads of mail brought by Imperial Airways, under the Empire All-up Airmail Scheme, were automatically carried by air by Indian carriers. The Scheme encouraged the Airline to open new routes and increase flight frequencies in India.

To cater for the increased number of passengers Tata Airlines added the twin-engined do Havilland Rapides to their fleet. Rapides were the first radio equipped aircraft of Tata Airlines. In that year, the Airline lifted 431,760 lbs. of mail and carried 658 passengers.

Then came World War II. The Empire Airmail Scheme was suspended. All air transport operations in India were run directly for the Government and Defence Services. In a way the War was a blessing in disguise. It gave the Airline considerable expeience in the handling of more modern aircraft and the opportunity of training and employing a sizeable number of technical personnel.

**Postwar Plans**

The end of the War saw a boom in air travel in India. India was ready for the Air Age. To meet the demand, a fleet of 10 Douglas C-47s and C-53s was acquired from American Army surplus and converted to meet civilian needs. Services were resumed and frequencies increased. Passenger traffic grew beyond all expectations. The potential growth was so promising that Tata Airlines was converted into a public company and renamed "Air-India Ltd.," in July 1946.

In January 1947, TWA started a service to India. Air-India was appointed general agents for the American company. It was a happy and profitable business partnership. One of TWA's senior hostesses flew into Bombay from Kansas City in 1946 to train the chosen few, selected from a veritable army of applicants, who were later to become the first air hostesses in India.

And so Air-India's portly diminutive "Maharaja", famed in story and song, made his debut on the Route of the Magic Carpet. Today, he symbolises AII's "personalised service" the world over.

**Overseas Services**

Two months after Independence, the Government of India reached an agreement on the formation of Air-India International Ltd. to commence international air services. Government undertook to take up 49% of the capital with an option of acquiring 2%. The company was officially registered on 8th March 1948.

Air-India International inaugurated its first international service to London on 8th June 1948. The initial frequency of one flight a week was gradually stepped up to seven Super Constellation services a week with alternative stops at Rome, Paris, Prague, Dusseldorf, Zurich, Geneva, Cairo, Beirut and Damascus.

The year 1950 saw the inauguration of a new service from Bombay to Nairobi (East Africa) via Karachi and Aden, providing modern equipment on a route which served business and family interests of many Indians who have made their home in East Africa. Today there are two Super Constellation services a week to Nairobi.

**Airlines Nationalised**

On August 1, 1953, all the airlines in India were nationalised by an Act of Parliament. Air-India Ltd. was merged with six other domestic operators into Indian Airlines Corporation. Air-India International Ltd. was taken over by a reconstituted Air-India International Corporation.

The years since nationalisation saw a rapid growth in Air-India's operations. Lockheed Super Constellations were introduced, for the first time, on Air-India's route in January 1954. A new service to Singapore via Madras was inaugurated in July 1954. A month later, a new Far Eastern service linking Bombay and Calcutta with Bangkok and Hongkong was inaugurated. This route was extended to Tokyo in May 1955. A second weekly service to Tokyo was introduced in 1955 and a third in 1958.

**Mr. B. R. PATEL,** I. C. S.,
Vice Chairman & General Manager
Air - India International

Bhagvatprasad Raojibhai Patel, Vice-Chairman and General Manager of Air-India International was born on August 24, 1912 at Boroda, India.

An M. A. of Bombay University and A. I. A. (Lon.), he joined the Indian Civil Service in 1936 serving in Sind up to 1947 in various capacities.

He was in the Ministry of Food, Government of India and thereafter Chief Secretary to the Governments of PEPSU and Saurashtra.

He was the Director General of Shipping for a year before being appointed General Manager of Air-India International, in September 1955.

Mr. Patel has published a book on land reforms in Saurashtra.

Present Address: 'Hemprabha,' 68 Marine Drive, Bombay-1.

Yet another important route was added to Air-India's rapidly expanding network. In October 1956, the Bombay/Singapore service was extended to sydney (Australia). This service, the fastest between Bombay and Sydney, provides a through connection between Sydney and London. In August 1958, Air-India opened an entirely new route pattern for traffic between Europe and the East with the inauguration of its Delhi/Moscow service via Tashkent.

In April 1960 Air-India inaugurated a Boeing Jet service to London and on May 14th extended its Bombay/London service to New York. An important milestone in the growth of Air-India's operations was the inauguration of their own Cargo Service "The Flying Sherpa" on November 14, 1960, between india and the U.K.

**India's Progress**

India has extensive trade and business connections with countries in the West and the East. She straddles the traditional trade and travel routes between Europe and Africa, the Far East and Australia.

With the introduction of large capacity longhaul Boeing Intercontinental aircraft on AII routes and extension of its operations to U.S.A. and East Africa, AII's traffic will increase appreciably and will make a substantial contribution to the growth of world civil aviation.

It is against this background that India's progress in international air transport has to be viewed. India's international air services fall into two categories.

a. Intercontinental or long-haul

b. Regional (to immediately neighbouring countries) or short haul.

Progress can be judged best by performance and rate of developments. The AII statistics below show the total annual capacity operated, revenue passengers actually carried and the percentage increase between 1949 and 1959.

| Year | Capacity in tonne-Km ** | % increase on the previous year | Revenue passengers carried ** | % increase on the previous year |
|---|---|---|---|---|
| 1949 | 10,499 | — | 8,000 | — |
| 1950 | 16,378 | + 55.99 | 11,000 | + 37.50 |
| 1951 | 21,573 | + 31.72 | 16,772 | + 52.47 |
| 1952 | 21,012 | — 2.60 | 15,063 | — 10.19 |
| 1953 | 26,538 | + 26.30 | 26,527 | + 76.10 |
| 1954 | 35,129 | + 32.37 | 36,563 | + 37.83 |
| 1955 | 51,025 | + 45.25 | 50,710 | + 38.69 |
| 1956 | 64,091 | + 25.61 | 60,008 | + 18.33 |
| 1957 | 75,465 | + 17.75 | 73,737 | + 22.80 |
| 1958 | 85,407 | + 13.17 | 75,589 | + 2.51 |
| 1959 | 98,016 | + 14.76 | 87,601 | + 15.89 |

** in thousands

**Increase in 1959 over 1949**

| | | |
|---|---|---|
| Capacity | ... | + 833.57% |
| Passengers | ... | + 995.01% |

**Preparing the ground**

From this study it is evident that Air-India have reason to be satisfied with the contribution made by the airline towards the development of world air transport. This remarkable progress has been achieved by:

a. Latest equipment

b. Technical skills

c. Reputation for good service

**Latest Equipment**

Air-India's policy has always been to purchase only the finest and the most suitable type of aircraft. In this respect Air-India has been ahead of many airlines on the competitive routes. The recent acquisition of three Boeing 707 Intercontinental Jets shows that India is well ahead in the Jet Age.

The performance characteristics of the Bœing 707 Intercontinental were considered in great detail by Air-India before they were purchased. It is an aircraft with excellent high-speed handling. It possesses the ability to operate with efficiency over long intercontinental routes. In short, Air-India went to the Bœing Company for the finest and largest

aircraft and to the Rolls-Royce Company for the world's fastest, quietest and most powerful jet engines.

**Technical knowhow**

To help develop the requisite technical skills, an intensive jet training programme for Air-India pilots, flight engineers and ground personnel was drawn up with the help of technical experts from the Boeing Airplane Co. in the U.S.A. and from Rolls-Royce Company in the U.K. Teams of flight crews and engineering personnel were sent to the U.S.A. and the U.K. for intensive training and certification for jet operations.

Air-India also installed a Boeing 707 Simulator at Santa Cruz. The Simulator is basically a ground aircraft in which the engine, wings, control surface and gear have been replaced by electronic computors. By the use of this Simulator Air-India has cut down training cost and the actual time required to check out a Pilot by at least 40 percent and provide the best in familiarisation for the crows.

**Customer Service**

When considering the standards of service, it is important to remember that Air-India has to compete with the service offered by other airlines on international routes. Air-India, therefore, must provide the very best of service to our passengers.

A new Customer Service Department has been set up recently by Air-India to give better and more efficient service to passengers on ground and in flight. Foreign chefs and catering staff have been employed to train Air-India staff.

A frequently voiced criticism of air travel is that time spent on ground in travelling to and from airports and that spent in getting passengers and baggage into the aircraft, seems disproportionately long in relation to the time spent in the air. There has still to be much progress before the first part of that problem is solved. But strides are being made to speed up the movement of passengers and freight at airports.

With each Boeing aircraft costing Rs. 2.75 crores maximum utilisation becomes more important than over. The cost of owning a jetliner—interest and depreciation—is like the second hand of a clock; it goes on forever, whether you are flying it or not. An airplane makes no money when it is on the ground. Short transit stops and quick turn-arounds are, therefore, not only essential but a must.

Air-India have scheduled 6 flights a week to London from Bombay, 5 services a week from London to New York, 2 flights a week to Tokyo and one to Nairobi.

Air-India recently announced plans to acquire two more Boeing 707 Intercontinental jets, for delivery by March 1962. Air-India will then have a fleet of six giant jets and will operate daily flights to London and New York, two flights a week to Nairobi and Tokyo and one flight a week to Moscow and Sydney.

Flying at 600 m.p.h. above the weather, the Boeing has slashed flying time on all Air-India sectors by more than half. Typical Boeing flight schedules on Air-India routes are:

| | |
|---|---|
| Cairo/Bombay | 5 hrs. 30 mts. |
| Calcutta/Bangkok | 2 hrs. 20 mts. |
| Bangkok/Hongkong | 2 hrs. 45 mts. |
| Hongkong/Tokyo | 4 hrs. 10 mts. |

Powered by Rolls Royce Conway engines, Air India Boeings ensure quieter, smoother and faster air travel. In addition to their speed, the Boeing Intercontinentals are capable of flying at an altitude 35,000 to 40,000 feet, well above adverse weather conditions. The 707s will also offer maximum safety, reliability and comfort.

Air-India's Boeings represent a vast improvement in flying conditions. Inside the quiet, spacious cabin, passengers will be delighted by the tasteful Indian decor with first and tourist class seats in a soothing colour scheme. A delicate tracery design in ivory and gold, reminiscent of old Banares brocades, decorate the cabin interior and entry area, while Indian dance motifs in subdued colours are repeated on side panels, conveying the splendour and luxury of the palaces of ancient India. On board, Indian air hostesses in exotic sarees look after the passengers with traditional hospitality and courtesy.

**Partnership Agreement**

Speed—reduction in actual travel time—is not the only commodity the airlines sell. Travel time includes convenient connections and departures coupled with high frequencies, regularity and short en route stops.

The Tripartite Partnership Agreement which B.O.A.C., Qantas and Air-India signed in Bombay on December 4, 1959, will enable the three airlines to offer the travelling public an unrivalled airline service by coordinating their schedules and reservation systems.

The airline network covered by the Agreement extends from Bombay eastward to Australia, Hongkong and Japan and west-ward from Bombay to New York. Each airline will sell the services operated by the other.

For Air-India, the next few years will be a challenge. But with their operational, technical and commercial experience gained over the past 12 years, Air-India is confident that they will be in a position to meet this challenge.

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# Targets of Cloth Production in the Third Plan

The draft outline of the Third Five Year Plan has envisaged that the cotton cloth production in the country will increase to 9,300 million yards by 1965–66 and has proposed the following targets for the various sectors of the Cotton Textile Industry.

| | Target of annual production (1965–66) |
|---|---|
| Mill sector | 5,800 M.Yds. |
| Handloom | 2,800 ,, |
| Powerlooms in the Handloom Sector, other powerlooms, Khadi etc., | 700 ,, |
| | 9,300 ,, |

Ever since the publication of the draft of the Plan in June 1960, a controversy has arisen over the allocation of targets amongst the different sectors. Two articles were published in a leading newspaper of Bombay examining the question of fixation of targets; editorial comments on the subject have also appeared; and recently the Indian Cotton Mills' Federation has published a booklet entitled "Third Plan Targets for Handlooms, Powerlooms and Mills", which purports to be a memorandum containing "the results of its own studies in the matter". The central points discussed in all these publications have been the extent of cloth production by the handloom and powerloom sectors and the correctness of the official statistics in this regard. An attempt has been made in all these publications to establish that production by handlooms is not as high as is claimed by official figures and that much of the increased production attributed to them is accounted for by powerlooms. Efforts have also been made by the authors of these publications to estimate how much of the total cloth production from mill yarn in the decentralised sectors could be attributed to handlooms and how much to powerlooms. The identity of their estimates furnished by the various independent studies as claimed by the authors would appear to be remarkable and significant. In this article it is proposed to set out the position as it is at present and examine the various asumptions made and conclusions reached in these studies.

At the outset, it has to be pointed out that it is not practicable to adopt for collecting statistics of production in handloom industry a procedure similar to the one adopted in the case of the organised mill industry where the various units are required to furnish monthly returns. In the first place, the handloom industry is a vast industry, spread all over the country. The industry is mainly a household industry and is manned largely by illiterate weavers who do not (and cannot be expected to) maintain any records relating to production and other aspects. It is, therefore, very difficult, if not impossible, to contact all the units regularly for the purpose of collection of statistical data. Even if such a scheme is visualised, it would require a gigantic organisation involving a lot of public money. The production in this sector had thus to be deduced from the volume of mill yarn delivered for civil consumption. Certain assumptions have been made

regarding the percentage of yarn consumed by the handloom industry from out of the yarn delivered and the average quantity of cloth that can be woven from one pound of yarn. The assumptions were based on the conditions obtaining in the days of yarn control.

In view of the difficulties mentioned above, it has to be admitted that no great degree of accuracy can be claimed for the available figures of production in the handloom sector. The All India Handloom Board had, right from its inception, realised the importance of making proper arrangements for the collection of reliable statistics relating to the handloom industry. Assistance was given to various Universities and academic bodies to conduct survey of the handloom industry in particular regions. These surveys were to be in the nature of pilot studies, which would bring to light the various problems facing the industry in general and not particularly collect data on production only. Simultaneously, the State Governments were requested to initiate steps for collecting statistics relating to production, to begin with at least in respect of the cooperative fold. When in the Second Five Year Plan the handloom industry was assigned a target of 700 million yards of additional production, the Board started thinking of collecting production statistics in respect of the entire industry on a direct and systematised basis. For this purpose, an Expert Committee with a representative from the Central Statistical Organisation, Cabinet Secretariat was appointed to evolve a suitable procedure for collection of handloom statistics. The Committee recommended the collection of data on a statistical sampling basis and the recommendations were approved by the Government of India. Assistance at the rate of 25 nP. per registered loom per annum is being given to the State Governments for purpose of collecting statistical information. So far, the scheme for collection of statistics has been sanctioned to nine States having with them 18 lakh commercial looms which cover about 70 per cent of the commercial looms in the country. It is hoped that the scheme would be extended to all States before the end of the current year. When the statistical schemes, as mentioned above, are fully implemented by the various State Governments, there will be a continuous flow of reasonable accurate statistical information. It would thus be seen that Government did not wish to rely permanently on the estimates based on yarn deliveries but had taken steps to assess the production in a direct manner.

As far as the powerloom industry is concerned, its size at the beginning of the Second Plan was known to consist of about 6,000 units having over 27,000 powerlooms. This industry is also widely scattered and a majority of the units (about 4,000) are of smaller size having less than 5 looms, working on cottage basis. For these reasons, the response from the units for furnishing statistical returns, *although, statutorily required*, remains very poor. At present only about 600 units furnish the returns regularly, which works out to nearly 10 per cent of the total units.

The Indian Cotton Mills' Federation has estimated that the production by the handloom and powerloom sectors at present is respectively of the order of 800 million yards and 1,365 million yards as against the estimate of 1,821 million yards and 337 million yards based on the empirical formula of yarn deliveries. The two sets of estimates vary so widely that it is necessary to examine the assumptions made and the basis of estimation adopted. The basis for the official estimates has already been reviewed in the earlier paragraphs. We may now look more closely at the method of estimation adopted by the ICMF.

**Estimate of Handloom Production**

The I.C.M.F. has made use of certain data relating to handlooms in the Co-operative sector published by the All India Handloom Board and the Reserve Bank of India for estimating the production in the industry as a whole. The I.C.M.F. has been good enough to indicate in an annexure to the memorandum the assumptions made in the process of estimation. A scrutiny of these would show that many of the assumptions have been made and the published data relating to the Co-operative fold made use of without regard to the actualities of the situation. For example, from the figures given in the table at the end of Paragraph 7, a conclusion has been drawn that there has been a "drastic drop in the production of handlooms." Such a conclusion, although appearing to be obvious from the figures of per loom production given in the last column of the table, would not stand the test of a close scrutiny. It may be mentioned that it was in 1956 that the


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various State Governments started, at the initiative of the All India Handloom Board, collecting production statistics from weavers' co-operative Societies. The State Governments did not have at that time any proper machinery for collecting and compiling the data; also not all the Co-operative Societies were familiar with the manner of reporting and many of them did not even have the staff to compile and send the production returns. On account of these reasons, only a few societies and those too that were well off, responded. In the subsequent years, thanks to the persuasion of the Board and the State Governments, more and more societies started furnishing the returns. (Even at present, the coverage is not complete and only about 50% of the looms are in the reporting fold). As the reporting fold enlarged, more of the societies, which were not well off, also started submitting production returns. This has perhaps resulted in low productivity of loom due to existence of more idle loom in the newly reporting societies. A comparison of the average of the various years, therefore, really involves a comparision of the performance of societies of differing degress of efficiency at different points of time and it is needless to emphasise that conclusions from such comparisons can be misleading, if they are not drawn with proper care. Similarly, it is surprising that in interpreting the data published by the Reserve Bank of India. The Federation should have come to the conclusion that the percentage of working looms to registered looms in 1958—59 was 54.0. In this instance, it was not fair on the part of the Federation to have kept the number of looms working at 6.26 lakhs, while increasing the total number of looms from 9.63 lakhs to 11.59 lakhs.

Another instance in which the I.C.M.F. has made use of the data published by the All India Handloom Board without realising their significance is provided in their estimation of the total production in the co-operative fold of the handloom industry. Probably the Federation was not aware of the fact that the number of looms shown as reporting societies, including *both active and idle.* The figures of per loom production given in the last column of the table at the end of Paragraph 7 were, therefore, 'gross' figures. The appropriate figure which should have been multiplied by 606 yards for arriving at the estimate of the production should have been 12 lakhs and not 7.80 lakhs, as has been done by the Federation. Proceeding on the same lines as the Federation, one may estimate the production in the Co-operative fold at 374.7 x 12.00/6.18=728 million. yards. It may, therefore, be concluded that the effect of the Federation not having properly interpreted the data has been the underestimation of the production in the Co-operative fold.

For estimating the production in the sector outside the Co-operative fold, the Federation has assumed a percentage of active looms of 55 and a per loom production of 550 yards. The discussions on this item given in Paragraph 10 of the Memorandum, have, however, not been based on any available information. In the absence of any available data, the normal procedure should have been to assume that conditions outside the Co-operative fold are similar to those within, instead of trying to assign arbitrary values to the parameters involved. The cumulative effect of all these restrictive assumptions made by the Federation has resulted in a production at a lower figure (Purposively, perhaps) than what one would arrive at under plausible assumptions. Adopting the same line of estimates as the Federation (sic) and after providing for the errors in its interpretation of the published data as pointed out in the earlier paragraphs, one may expect the production in the handloom industry to be of the order of 1382 or 1400 million yards. In fact, the production in the handloom industry can be expected to be higher than this, as it is known that many looms, which are in the co-operative fold, also depend to some extent, on the institutions in the sectors outside for work. The production by such looms in the sectors outside the co-operative fold has not been taken into account in the above estimation.

**Estimates of Powerloom Production**

The Federation has estimated the production in the powerloom sector at 1365 million yards by substracting its estimate of the production in the handloom sector from the estimate of the combined cloth production by the two sectors. It has also attempted to verify whether the powerloom sector has the capacity to produce the estimated 1,365 million yards. For this purpose, the Federation has made use of the data relating to the 10% of the units which have been furnishing returns. The Office of the Textile Commissioner had never attempted to estimate the total production in the powerloom sector from the returns received since they were statistically non-random, their coverage poor and they were not


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coming proportionately equally from units of different sizes. The Federation has however, projected this truncated data for estimating total production in the Powerloom Industry and has incidentally assumed that all the powerloom both registered and unregistered irrespective of size and other variable factors are working under identical conditions. Also the Federation has carried out its analysis on the basis of the opinion of competent observers that the number of powerlooms working on cotton yarn is in the neighbourhood of 80,000 to 90,000. As far as officially known, there are 27,000 registered powerlooms; the recent censuses in the various States have brought to light the existence of about 18,000 unauthorised powerlooms. These two figures would indicate that the size of the cotton powerloom sector is of the order of 45,000 looms and not 90,000 as assumed by I.C.M.F. It has assumed that each powerloom works for 2.4 shifts a day and produces on an average 28,400 yards per annum. In the context of the fact that many of the non-reporting powerlooms are installed in dispersed areas with one, two or three looms at each place, and which, taken as a whole, have neither the facilities nor the resources necessary for continuous working of even a full single shift, the validity of these assumptions is open to doubt. In passing, it may be mentioned that for estimating capacity in the organised sector, a figure of only 24,000 per year per loom is taken as basis.

The significant aspect of the analysis undertaken by the Federation on the production by powerlooms is that it relates mostly to an assessment of the capacity of the powerloom industry consisting of authorised and unauthorised powerlooms to produce 1,365 million yards rather than to the actual production for a given time period. It is well known that the capacities of the handloom and powerloom sectors are much larger than what are put to productive use and an approach through an analysis of capacities is more likely to remain an exercise is simple arithmetic than an audit of performance.

The present official estimate of the production by the authorised sector of powerlooms is of the order of 350 million yards. The Central Board of Revenue is also collecting output data for all excisable commodities directly from each unit. The excise authorities cover the units outside the excise fold also in order to keep a vigilant eye on their growth. From the information which they have collected in respect of the authorised sector of the powerloom industry, it is noticed that the overall production in that sector is of the order of 300 and odd million yards which nearly tallies with the official estimates.

The discussions in the foregoing paragraphs would serve to illustrate that incomplete data aided by assumptions are likely to lead to divergent conclusions. Our examination of the assumptions made by the Federation, it is hoped, would conclusively establish that their effect has been to under-estimate the production in the handloom sector and overestimate that in the powerloom sector. Not that any great degree of accuracy is claimed for the alternative set of estimates presented above either. We have already explained the various steps taken by the All India Handloom Board to evolve a direct and reliable system for estimating production. The Government of India have also appointed a High Power Committee to advise them on the collection of data from Small Industries. The Annual Industrial Census, the Sample Survey of Manufacturing Industries and the National Sample Survey have schemes for covering large, medium, small and Cottage industries. When these schemes get into full force, they will no doubt throw important statistical information on all sectors of the Industry.

The Government have also recently decided to regularise the unregistered powerlooms through the issue of formal permits by the Textile Commissioner subject to certain conditions. The existence of such unregistered powerlooms and the contribution which they would be making to the cloth production in the country have already necessitated rethinking on the role of the different sectors in the Third Plan. It is hoped that as a result of the regularisation of the unregistered powerlooms, a better idea about the size and production possibilities of the sector would be available.

In its Memorandum, the Federation has touched upon a few other points, one of which relates to the revenue which Government would have gained had they allowed the mills to manufacture the quantity of cloth (as estimated by the Federation) which was produced by powerlooms. Apart from the validity of the Federation estimate, it may be noted that already all powerloom units having more than 4 looms were in the excise fold; and from the financial year 1961—62 units having three or four looms and working for more than one shift are also in the excise fold.

It would be idle to deny the effects of the growth of unauthorised powerlooms in the handloom sector and the organised mill sector, particularly the former, since they have all the advantages of both the sectors, without, at the same time, being subject to the limitations or restrictions applicable to the others. The various steps taken by the Government to bring these looms within the pale of law and taxation have been mentioned in the foregoing paragraphs. It would nevertheless be stretching things too far to suggest, as has been done in some quarters, that all the money spent for developing the handloom sector has benefited not the handloom weavers but the powerloom owners, who work both authorised and unauthorised looms. The bulk of the benefits has in fact accrued to the handloom weaver. Government are fully alive to the danger to the handloom industry arising from the fugitive and elusive unauthorised powerlooms and are taking all possible steps to check the evil. It is upto all interested in the progress of the decentralised sectors of the Industry, and particularly in the well being of the vast masses of population dependent on handlooms for their existence, to assist Government in every possible way to detect and arrest the growth of this evil.

[ Re-produced from the Monthly Statistical Bulletin, February 1961 issued by the Office of the Textile Commissioner and the Handloom Journal, March–April 1961, published by the All India Handloom Board, Bombay.

The views expressed in the article do not necessarily represent the views of the Government. ]

# Role of Indian Standards in Industrial Development

## Aims of Standardization

An eminent thinker once remarked that standardization is to industry and commerce what culture is to society; that is to say just as rules of civilized behaviour regulate social intercourse of man and his appreciation of cultural values and enrich his intellectual and spiritual life so does standardization help to regulate the conduct of commerce and trade in smooth and efficient manner. Standardization assists in improving the productivity and efficiency of man and machine. It reduces unnecessary and costly variety of products, provides for interchangability of parts and supplies and when carried out properly, it results in easier inspection, simpler maintenance and better workmanship.

## Concept of a Standard

Perhaps the best definition of a 'Standard' is

"a verbal or written formulation, or a physical representation in the form of a graph or sample or model,

which serves to define, or designate, or specify certain features (or basis of measurement) of a unit, an object, an action, a process, a method, a practice, a capacity, a function, a performance, a measure, a quantity, an arrangement, a condition, a duty, a right, a responsibility, a behaviour, an attitude, a concept or a conception, or a combination of any of these,

with the object of promoting economy and efficiency in production, disposal, regulation and/or utilization of goods and services,

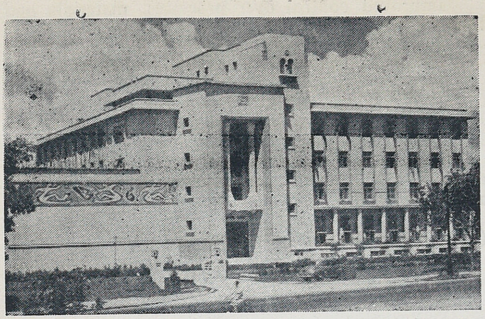
by providing a common ground of understanding among producers, dealers, consumers, users, technologists and other groups concerned."

## National Standards

Standards are formulated and used by various agencies. For instance an individual may lay down a standard to suit his particular needs, such as; a specification for a piece of furniture or a house or a factory. Similarly a company may prepare by common agreement between its various departments, standards for guiding it; purchases, manufacture and sales activities. A group of related trade interests and associations may also prepare standards acceptable to a particular group or trade only but standards if they are to be effective have to be evolved at a national level by integrating the interests of different groups of trade and industries involved. In India the national standards are prepared by the Indian Standards Institution (ISI) set up in 1947. The ISI, which is a non-Government and non-profit making organization works in close collaboration and with full support of all interests in the country concerned in standardization, that is Central and State Government Departments; industry in the private and public sectors; technical institutions, research and testing laboratories, etc.

## Developing Indian Standards

The ISI does not make standards, rather it makes standards possible. The bulk of the technical work



*Manak Bhavan at Mathura Road, New Delhi*
*The Headquarters of the ISI*

towards the preparation of standards is done by the ISI Technical Committees. The staff in the ISI Directorate coordinates the work of these committees, undertakes necessary secretariat duties, collects and supplies data, organizes the investigations and research work, gets technical information required by the committee, assists in formulating drafts, collects comments and ensures that the standards are properly examined at each stage of formulation, but on all technical questions the committees take decisions. These committees comprise of representatives of producers, dealers, consumers, industrialists, technologists, research and testing organizations and Government departments. The number of such technical committees, which is increasing gradually, exceeds the figure of 900 and there are about 10,000 experts serving in these committees. Through the efforts of these experts and specialists who pool their know-how and experience for the national cause without any remuneration from the ISI, it has been possible for the ISI to produce more than 1,700 national standards in a short period of 13 years of its existance. These standards cover a wide range of field and may be conveniently grouped under the following heads :

(a) **Agricultural and Food Products :** beehives and beeswax ; cocoa products ; confectionery ; dairy products and equipment ; edible straches ; cereals products ; food grain storage structures and regulated market yards ; post control products ; poultry and animal feeds ; sugars and vegetable oils.

(b) **Building :** Aggregates and sands ; assembled components ; bricks and stones ; builder's hardware ; cement and concrete ; codes of practice for timber, building construction, structural safety, wiring, laying of floors and roofs, etc ; electrical installation and illumination ; refrigeration and air-conditioning ; fire-fighting equipment ; floor coverings ; lime and gypsum ; methods of test for building materials ; pozzolana ; concrete reinforcement ; roof coverings ; service equipment and accessories ; far and bitumen ; timber and timber products, such as doors, windows and other building furniture.

(c) **Chemical :** Chemicals, fine ; Chemicals, heavy ; coal and coke ; essential oils ; glass and glassware ; leather and leather products ; metal containers ; oils and greases ; office stationery and equipment ; paints, lac and allied materials ; petroleum products and lubricants ; plastics ; rubber products and soaps.

(d) **Electrotechnical :** Appliances and wiring accessories ; batteries ; cables, conductors and accessories ; electronic components ; electroplating ; instruments and meters ; insulators and accessories ; radio and acoustical equipment ; rotating machinery ; and transformers and switchgear.

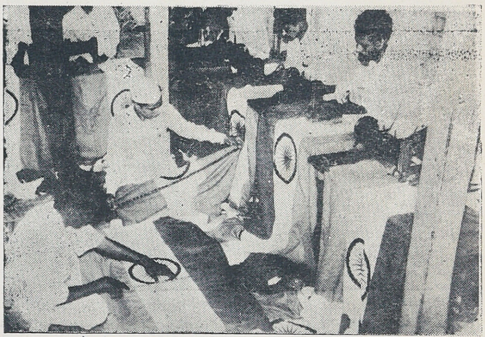
(e) **Engineering :** bicycle components ; coated abrasives ; cutlery ; machinery ; precision instruments ; sewing machines ; sports goods ; tools ; weights and measures ; and oil pressure lanterns and stoves.

(f) **Structural and Metals :** aluminium and aluminium alloys ; chemical analysis of metals ; copper and copper alloys ; ferro alloys ; foundry ; lead, zinc, tin, antimony and their alloys ; general requirements regarding preferred sizes, thicknesses of sheets, diametres of wires and supply conditions of metals, etc ; ores ; physical tests of metals ; pig iron, cast iron and malleable cast iron ; precious metals ; refractories ; solders ; steel products and welding, etc.

(g) **Textile :** Cotton yarn and fabrics ; jute and jute products ; rayon and rayon fabrics ; ropes ; silk and silk products ; textile mill stores and accessories ; textile test methods ; wool and wool products ; coir fibre, yarn and coir products ; and handloom products.

(h) **General :** documentation and book production ; statistical quality control guides and tables for interconversion of values from one system of measurements to the other ; drawing practice, making and labelling, etc.

In addition standards for about 1,300 subjects are under various stages of formulation and there is about an equal number on the waiting list to which new subjects are being continuously added. Within the next few years ISI expects to produce standards relating to every major field of trade and industry.



*Checking and Testing of Products*

**Why Use Indian Standards?**

The fundamental feature of Indian Standards is to facilitate control and direction and to simplify processes necessary for large scale production. They are formulated with the concurrence of all interested concerns and they are truly national in character and not meant for any specific interest.

Indian Standards are *unbiased* as they are prepared by technical committees having fair representation from all interested concerns. They are based on merits rather than commercial expediency, at the same time they are practical and supply a commercial need.

In short, Indian Standards are intended to serve as a guide to manufacturers, as a basis of trade agreement and as an instrument to help technologists to judge quality and performance and as a solution to recurrent problems of designer and construction. Standards provide for inter-changability of parts and supplies and when properly implemented they result in easier inspection, simpler maintenance and better workmanship.

In general the benefits from Indian standards to producers, consumers, technologists and trade can be enumerated as follows :

**(a) To the producer the standards mean**

Rationalization of processes of manufacture ;

*The Production of ISI Certified goods entails Checking and Testing of the Products at different stages during the Production*

Improved control over processes, materials and labour ;

Elimination of waste of material and effort ;

Higher rate of production ;

Reduction of cost manufacture ;

Reduction of inventories of stocks, both of raw materials and products ; and ultimate increase in sales and hence profits ;

**(b) To the consumer, the standards offer**

Assurance of quality of goods and services purchased ;

Better value for money spent ;

Elimination of disputes with supplier or at least convenient method for settling such disputes ;

**(c) To the trade, the standards imply**

Minimization of delays, correspondence and discussions resulting from inaccurate or incomplete specifications of the stores ordered ;

Reduction in sampling, inspection and testing ;

Workable basis for acceptance or rejection of goods, and for dealing with consequential disputes ;

Opening up of larger markets for purchase and sale through non-recognition of trade marks or fancied supriority of products ; and

Reduction in cost of handling transactions, leading to greater turnover and higher profits.

**(d) To the technologists, the standards furnish**

Accepted methods and materials which expedite designs ;

Facility for introducing improvement in products and processes ;

Increased knowledge of properties, possibilities, and application of materials ;

Guidance for formulation of research and development programmes ;

Assistance in meeting difficult specification requirements of special items.

**Implementation of Indian Standards**

Indian Standards are purely voluntary. Their use is not binding even on the members of ISI. But as they represent the largest consensus of views of producers, consumers, technologists and others concerned on the subject this makes them eminently suited for implementation immediately on production. Realizing their importance on the national level most of the progressive industrialists follow Indian Standards in their production plans and also supply and purchase programmes. The Central Government, some State Governments and most of the State-owned and State sponsored industries have made it a part of their policy to implement Indian Standards as soon as they are published. Out of 1434 Indian Standards published upto 31 March 1961, 1,173

had already been implemented and adopted by State and Central Government Departments.

### ISI Certification Mark

Indian Standards no doubt promote the growth and development of indegenous products but the ordinary consumer has no means of checking the quality of the product. To serve both the buyer and the producer the ISI Certification Marking Scheme which derives its authority from the Indian Standards Institution (Certification Marks) Act, 1952, has been in operation for the past five years. The presence of an ISI Certification Mark on an article is a guarantee that it has been checked and tested by a competent, independent, national institution and that it has been found satisfactory. The licence for the use of ISI Certification Mark is issued only after the ISI has assured itself about the standard quality of an article produced by a manufacturer. Before the issue of the licence, an ISI Inspector visits the factory to inspect the quality of raw-materials and finished products, as also the procedure and equipment for testing the raw materials and finished goods. He prescribes the frequency at which the licencee has to carry out tests to get the Certification Mark on his products. He checks the articles, as they pass through several stages of manufacture. Periodically, the goods are picked up from the manufacturing line and sent for testing to independent laboratories, like the Government Test House and the National Physical Laboratory. The ISI staff makes surprise visits to these factories and checks whether the manufacturer is complying with the prescribed requirements. The inspection staff of the ISI also picks up, at random, articles carrying the ISI mark from the market and gets them tested for quality, and also ensures that the mark has not been used by any unauthorized party.

About 300 licences have already been granted to different manufacturing units covering 93 products such as soaps, biscuits, babyfood cornflakes, aluminium utensils and sheets, national flag, napthalene, rectified spirit, certain chemicals, drums and oil pastes for paints, fountain pen inks, insecticides, dry cells, motor car batteries, electric wires and cables, electric motors, cement, concrete pipes, tea chests, brass rods, bars and tubes, etc. The Institution is taking steps to extend its Certification Mark to cover more and more articles of domestic and personal use, but, the scheme can be made to grow faster if the consumers acquire the habit of always demanding ISI certified goods and giving them preference.

### Indian Standards and Export Promotion

Export promotion has become a matter of most vital concern to us to gain foreign exchange for goods we import for our industrial development. No nation can export successfully unless she has standards in which peoples of other nations have faith. Not only Indian standards are acceptable in India, but they are recognized by the foreign buyers as well, since Indian Standards are prepared after taking into consideration the views of diverse interests in India and also those of foreign consumers through the over-seas standards bodies. So, Indian Standards are well suited both for internal and foreign trade. Again, being an ative member of the International Organization for Standardization, ISI has gained good reputation and recognization in foreign countries. Indian Standards are formulated after taking into consideration the climatic needs of the tropical countries, so goods conforming to these standards are particularly acceptable to the neighbouring Asian and African Countries.

Indian Standards are steadily improving the quality of indigenous products. As indicated earlier among the numerous standards published by ISI there is a large number which relate not only to traditional items of India's export, but also to manufactured goods, exports of which are being expanded to earn foreign exchange. The first basic principle in export promotion drive is that our goods must conform to the standards formulated by ISI. Not only that, exportable goods, if they carry the ISI Certification Mark, convey to our foreign buyers the third-party guarantee of their quality.

In short Indian Standards are a key to reducing waste, eliminating duplication and increasing efficiency and productivity. It is imperative, therefore, that they should be developed and applied in increasing numbers to promote the development of national industry and to secure larger market for indigenous products.

* * *

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# The Paint Industry

G. H. GATES-REED, M.I.A.M.A.
Shalimar Paint, Colour & Varnish Co. Ltd., Calcutta-1

The part being played by the Indian Paint Industry in the forwarding of India's Industrial Revolution is not as widely appreciated as it should be—a fault possibly lying at the door of the Industry itself. But not entirely so for, where as in our day-to-day contact with articles, domestic or industrial, a refrigerator, a car, a toy, a piece of furniture, we are conscious of those objects for what they are, for their functional value, only occasionally do we react to or appreciate that these are nearly always painted or finished with some product of the paint industry. For instance, even when considering the choice of colour of a car the average buyer thinks only of it as a "colour" and not as a paint, a separately manufactured product—he rarely questions its quality, the thoroughness of its application—and this is true of almost everything where the purchaser is not involved in the application of the paint himself or where colour is only a secondary consideration.

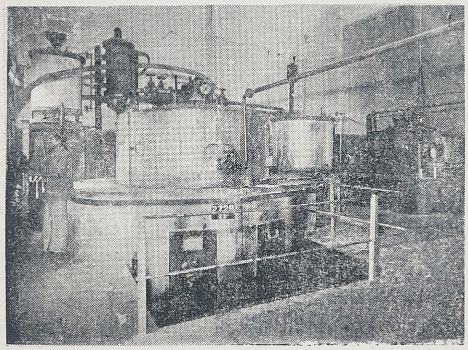
This point has been made at some length in an endeavour to bring into focus the really formidable job the Indian Paint Industry has had to tackle with the general industrialisation of the country and has in fact tackled extremely well. In Table 'A', products are listed which are being made in India in ever increasing quantities which ten, twenty years back were all imported—imported with their protective and decorative paint coats 'brightly' on! That is the significant fact.

The paint industry quite obviously, has its finger in the pie of just about every industry not only in the supply of specialised product finished of a very wide range of varied formulations but in the supply of the day-to-day domestic paints used for the protection and decoration of the factories in which these new manufactures are now being turned out and all their ancilliary buildings, quarters, plants etc. The point for emphasis is that the industry has and is coping. Official statistics do not reveal the full story for paint production is converted to tons (tonnes, today) which, when dealing with liquids can cause misunderstanding for as with paint, the modern synthetic based finishes are very much lighter than their "old fashioned" (linseed oil and natural pigment based) predecessors which were the back-bone of the industry's trade in its formative years. The 71,100 tons quoted by the JOURNAL OF INDUSTRY & TRADE as the official installed capacity of the 53 major units submitting returns would not then tell the whole progress story if compared with the installed

capacity figures for the industry twenty years ago—were they available.

But it is hoped that the remarks in these opening paragraphs related to Table 'A' and the further points to be made, will give some idea as to the magnitude of the task taken on. There are other influencing factors which have increased the difficulties for the industry. One is the failure of many of the new industries, heavy and light, to fully appreciate the need to finish their products well and not to make cheapness of finish to prime object. Certainly, India will not capture or at any rate, hold, Export markets if the goods she sends out are not decoratively and well protected. As a corollary, many of the new industries have not installed correct finishing equipment (stoving, dipping, rolling and spraying apparatus), with the result that special paint formulations have to be made to give satisfactory results whilst being used under improved conditions. In some cases, the paint supplier has even had to help develop and fabricate the finishing equipment for his client. The number of tailor-made formulations that have had to be introduced to keep pace is truly formidable.

For instance, India today has a flourishing and expanding Electrical Industry—their requirements of insulating varnishes, compounds and general paints run into literally hundreds of different formulations. Their satisfactory production is far from rule-of-thumb for raw materials vary in quality from supply to supply, and as has been mentioned above, application conditions range from the perfect to the ludicrous. But all have to be material and error has been inevitable. And then, having been met, in the early years the offtake of the buyer is only limited as his business develops so that the paint manufacturer will carry a loss, unseen but real, in the development, experiment and research charges which he has to



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absorb. A great deal of equipment in both the research laboratories as well as in the production bays has had to be installed to meet these needs. True, the return will come eventually but it has been hard won and truly earned and may not necessarily come to the paint manufacturer who did the development work. Competition is extremely keen within the industry.

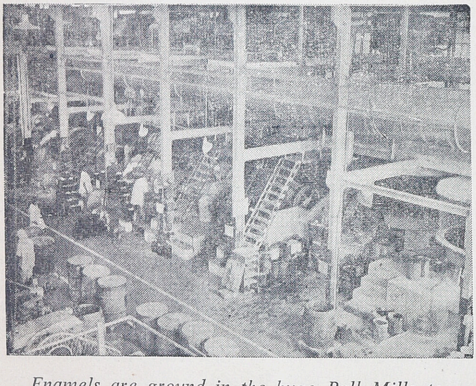
It is then with justifiable pride that the Paint Industry can review its efforts to keep pace with general developments over the last twelve years. India has been saved crores upon crores of rupees in foreign exchange, in return for the relatively limited amounts allowed for the import of manufacturing equipment and essential raw materials by the fact that the indigenous Paint Industry was on the mark, and is in fact, ahead of trends anticipating future needs. There is no need to import these specialised paints. The leaders of the industry, which has been operating on a modern basis since the turn of the century when Shalimar Paint commenced manufacture mainly to supply the marine paint requirements of the coastal shipping trade are fortunate in that they have maintained technical links with British, American and German contacts. The know-how is there. Even the smaller manufacturers had made available to them the

advisory service of a British Paint Technican, under the Colombo Plan. The industry is in a very healthy state.

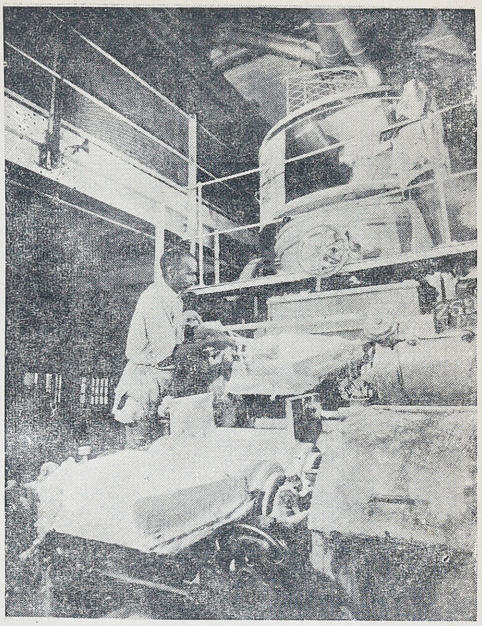
### 1960—61

1960 was a very important year for the Paint Industry in a number of ways. The influence of the introduction of the Metric System of weights and Measures, the formation of a single Indian Paint Association to replace the two previously in existance, the capital and capacity expansion of member companies, and the drive to develop exports, all initiated or finalised in 1960; will begin to produce their benefits from 1961 onwards.

Of the first change that to the Metric System, I wrote at length elsewhere in a special article on selling "the Metric way" that: "The implications of this change to the Paint Industry are perhaps more far-reaching than for most other industries in that, in implementing it, radical reforms arising out of the change will be introduced into the selling of paint. Under the present system liquid paid is sold by volume in two ranges of containers: the Imperial and the old measure gallon ranges (the O.M. gallon being four-fifths of an Imp. gallon) and it is also sold by weight. Under the metric system, the sale of liquid paint will be in the litre range but the additional supremely important point of possible reform is 'that State legislation could and, it is hoped, will be introduced to prohibit the sale liquid paint by weight altogether. The Central Government are sympathetically inclined to this recommendation by the Industry and, in point of fact, have suggested to all Co-ordinating Officers of the Standing Metric Committee in the States and Union Territories, that they advise State Governments with whom the power rests that a notification be issued under Section 8 of the State Weights & Measures Enforcement Acts to require liquid paints to be sold by volume only "so as to prevent mal practices." The matter now rests with individual State Governments. The Paint and Allied Products Sectional Committee of the Indian Standard Institution as far back as 1953, had recommended



*Enamels are ground in the huge Ball Mills to obtain superfine grinding after which they are tested and filled into a variety of containers*



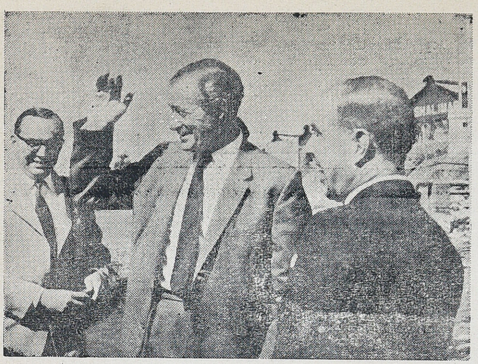
*Paint making from the mixer (top) through the rollers (centre) to the container*

that Government Purchasing Agencies, should buy liquid paints only by volume. It is hoped that this far-reaching reform will take place for it would benefit all—Government included, through increased excise. It would also benefit the uninformed buyer who can be easily deceived by the apparent low-priced liquid paint sold to him by weight."

The change-over for the Paint Industry is to be completed by the 1st April. Excise have already changed over and selling and billing for weight items is metric now as a great number of districts up and down India have "gone metric" for weight selling. The majority of the leading paint companies are selling by metric volume (the litre) also.

There is no doubt that these changes, when they become accepted practice, will prove of benefit to the Industry and to the purchaser for there are undoubtedly too many anomalies in paint selling at present, which apart from being inconvenient and expensive in that a great deal of money is tied up in stocks of several ranges of containers, are as authority has agreed, conductive to mal practices. The metric reform therefore is offering an excellent opportunity for rationalisation.

It has been the desire of the Industry and of Government over the last few years to solve a problem of the fact that the Industry was represented by two groups, the Paint Federation and the Indian Paint Manufacturers Association. After prolonged negotiations, on the 1st July 1960 the Indian Paint



*Mr. Duncan Sandys, British Secretary of State for Commonwealth Relations is seen above (centre) with (to his right) Mr. G. S. Whitehead and (to his left) Mr. W. R. Monk of Shalimar Paint*

Association was formed as a result of the amalgamation of the two Associations. Already this body has 40 members strong—the Governing Body consists of 10 members is more that the total membership of one of the old Associations. Undoubtedly, if goodwill is shown by all parties, the common approach that can be made to overall problems and to Government by the Indian Paint Association as a fully representative body will prove of value to the Industry and increase its ability to give even better service to Industry generally.

As to the capital and capacity expansion of the Industry, this has been apparent by a recent announcement made by certain of the leading Companies by the Indianisation of their share capital—an objective to expanding capacity and also by reason of the fact that the Government of India have themselves realised that as the momentum of industrialisation increases and the capacity of the Paint Industry would require to be stepped up. It was announced in the middle of 1960 that a new capacity of 20,000 tons was to be sanctioned and it was allotted to the northern region comprising the States of Uttar Pradesh, Punjab, Rajasthan, Jammu & Kashmir, Himachal Pradesh and Delhi and in the southern region, Madras, Andhra Pradesh and Kerala State. At the time of writing, the response from capital had not been great but certainly the opportunities are there.

Efforts are being made by the Paint Industry to develop their capacity for producing their own Synthetics, now the back-bone of paint formulation, and the position has now undoubtedly improved. For instance, in 1949, only approximately 16,000 gallons of Nitro-Cellulose lacquers were produced in India ; present production is in the region of 270,000 gallons and the industry has an installed capacity of around 8,00,000 gallons. Aluminium Paste, Phenolic, Alkyd Resin now being produced in India in increasing quantities, although the industry is still to a degree dependant on the Chemical Industry.

Until it is possible to produce these basic materials in India so that the heavy import duties can be avoided even with drawback arrangements, it is difficult for the Industry to compete in foreign markets against Western competition. This is understandable in that the paints being offered by the Indian Paint Industry in competition with the Western paints, the essential material which have had to be imported and have had duty paid upon them from the very countries with which we are trying to compete. It is a difficult problem but with the Government help an answer can be found.

The I.S.I. continue to do good work and have had a particularly busy time in relation to the metric ystem changeover.

The Indian Paint Research Association has now been formed after many years of discussion. The Research Association has under consideration the establishment of a Research Laboratory in Calcutta with possibly another in Bombay. It is to a degree modelled on the British Paint Research Station, Teddington.

The Government Test House at Calcutta still comes in for a great deal of criticism mainly because it is quite obviously overworked and under-staffed. It is to be hoped that the situation will be eased in the near future by Government action.

In conclusion, it can be categorically stated that the Industry has a prosperous future as undoubtedly the limit to demand had by no means reached. In addition, competition within the Industry is intense and that is healthy for all concerned. A general estimating basis is that for every additional million tons of steel and cement produced, 15,000 and 3,000 tons of paint finishes for those materials will be required for their protection. If you relate these figures to Government aims in the latest Five Year Plan without any reference even to the requirements of the private sector, it will be seen that my statement is based upon a reality and that there is every reason for the Industry to continue its expansion plans and expect a reasonable return for the hardwork it has done over the last few years.

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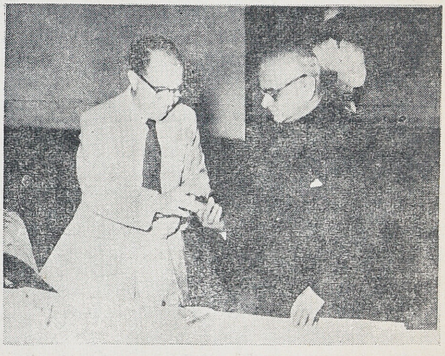


*Mr. Monk aud Mr. P. R. Ramanujam who retired from Shalimar Paint after 29 years of service*

TABLE "A"

# SOME PAINT CONSUMING INDUSTRIES AND PRODUCTS

| PRODUCTS | UNIT | 1950—51 PRODUCTION | 1960—61 ESTIMATED PRODUCTION | TARGETS FOR 1965—66 | |
|---|---|---|---|---|---|
| | | | | CAPACITY | PRODUCTION |
| Finished Steel | mill. tons | 0.98 | 2.6 | 7.5 | 6.9 |
| Industrial Boilers | Rs. crores | — | 0.6 | 29.0 | 25.0 |
| Machine Tools | ,, | 0.29 | 5.5 | 30.0 | 30.0 |
| Locomotives — Steam | Nos. | n.a. | 295 | 300 | 1,175 † |
| Wagons [in terms of 4-wheelers] | ,, | 2,924 | 20,000 | 33,500 | 109,866 † |
| Passenger Coaches | ,, | 479 | 1,210 | 1,420 | 7,837 † |
| Passenger Cars | '000 Nos. } | | 20 | 30 | 30 |
| Commercial Vehicles | ,, } | 16.5 | 28 | 60 | 60 |
| Jeeps & Station Wagons | ,, } | | 5.5 | 10 | 10 |
| Automobiles ancillaries including Trailors | ,, | — | n.a. | 2.5 | 2.5 |
| Motor Cycles & Scooters | ,, | — | 16 | 48 to 60 | 50 |
| Road Rollers | Nos. | — | 350 | 800 | 700 |
| Bicycles | mill. nos. | 0.10 | 1.05 | 2.2 | 2.0 (*e*) |
| Sewing Machines | '000 nos. | 33 | 300 | 500 | 450 (*f*) |
| Electric Transformers (below 33 kv) | mill. kva. | 0.18 | 1.35 | 4.0 | 3.5 |
| ,, Motors (200 h.p. & below) | mill. h.p. | 0.10 | 0.8 | 3.0* | 2.5* |
| ,, Fans | mill. nos. | 0.19 | 0.9 | 2.8 | 2.5 |
| House Service Meters | ,, | — | 0.45 | 2.5 | 2.1 |
| Cement | mill. tons | 2.7 | 8.8 | 15.0 | 13.0 |

(*e*) additional 0.5 million bicycles are expected to be produced in the small-scale sector.
(*f*) additional 1,50,000 sewing machines will be produced in the small-scale sector.
* these figures are for 300 h.p. and below.
† relates to the five-year period.

# Cashews Look Ahead

A. V. THOMAS, M.L.A.,
Chairman, Cashew Export Promotion Council
Cochin-3

It is believed that the cashewnut tree was first introduced into India during the 16th century by the Portuguese missionaries. Soil and climatic conditions being favourable, the cashew tree excelled in growth and fruiting in the coastal belts of South India. It is now growing extensively in many parts of India, the foremost commercial areas being confined to Kerala, Mysore, Madras and Andhra Pradesh. In the course of the past 400 years, the cashew has covered over 2.2 lakhs acres without any serious efforts by man. Though it was considered as a wasteland crop and given no special attention, it steadily grew in prominance and has built a thriving industry and export trade in South India.

The total production of raw cashewnuts in India at present ranges between 60,000 and 65,000 tons per year. This is hardly sufficient to feed the existing cashew industry in India. There are about 200 cashewnut processing factories in South India and their processing capacity is estimated at more than 2 lakh tons of raw cashewnuts per year. India is now importing yearly more than a lakh of tons of raw cashewnuts from East Africa.

This long felt need of our cashew industry and its dependence on foreign countries has been realised by the Government of India only after India attained independence. Planned improvement of the crop commenced with the second Five Year Plan. With the active assistance of the Central Government, various development programmes were prepared for bringing more acreage under cashew cultivation in as many as eight states. Incentives were provided to the growers to foster cashew cultivation through distribution of crop loans, assignment of lands on lease, and through pedigree plant material etc. During the second Five Year Plan (upto 31—3—1960) an additional acreage of about 1.447 lakhs acres are reported to have been brought under cashew cultivation.

In 1955, the Government of India set up an Export Promotion Council for Cashews also with the main object of augmenting our exports and diversifying the markets. Various promotional measures were launched by the Council to this effect. From an average export of 28,000 tons of cashew kernels valued at 11.3 crores of rupees during 1951-52 to 1955-56, our exports increased to about 31,000 tons valued at Rs. 14.5 crores in 1956-57 which again increased to about 38,800 tons valued at Rs. 18.9 crores in 1960-61. During these periods many countries emerged as new markets for cashews, of which special mention may be made of Japan and Iran. At present there are 47 countries importing

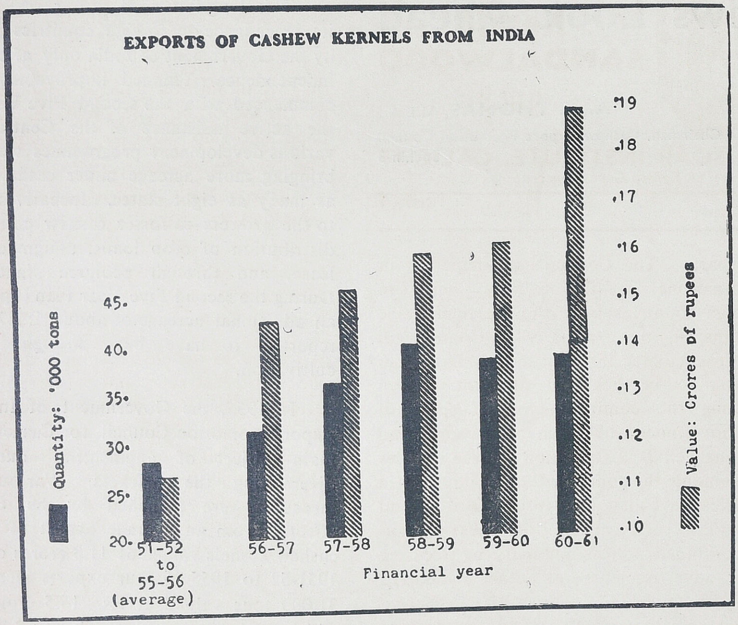
cashew kernels from India compared to 39 countries in 1956-57. The following table gives an idea of exports of cashew kernels from India during 1656-57 to 1960-61.

**Exports of Cashew kernels from India**

(Qty. in tons)

| Countries | 1956–57 | 1957–58 | 1958–59 | 1959–60 | 1960–61 * |
|---|---|---|---|---|---|
| Australia | 416 | 791 | 613 | 685 | 1,142 |
| Canada | 893 | 1,345 | 1,374 | 1,247 | 1,373 |
| Germany West | 806 | 420 | 918 | 1,145 | 871 |
| Germany East | 188 | 199 | 203 | 894 | 335 |
| Hongkong | 158 | 255 | 188 | 226 | 322 |
| Netherlands | 651 | 148 | 360 | 235 | 304 |
| Sweden | 215 | 140 | 175 | 206 | 148 |
| U.K. | 3,822 | 2,332 | 2,940 | 1,913 | 2,954 |
| U.S.A. | 21,256 | 28,225 | 26,355 | 26,304 | 25,425 |
| U.S.S.R. | 1,384 | 1,869 | 6,423 | 4,428 | 4,414 |
| Other countries | 992 | 434 | 824 | 881 | 1,425 |
| Total | 30,781 | 36,158 | 40,373 | 38,164 | 38,713 |

* Provisional




GRAPH

The following will give an idea of the main export promotional measures undertaken or proposed to be undertaken by the Council.

The commercial and visual publicity is an indispensable aspect of trade in modern times and in this respect advertisements and exhibitions play

a significant part. The Council's participation in various international exhibitions/fairs held in different foreign countries have showed remarkable results in augmenting our exports. The Council will continue to participate in almost all important exhibitions/fairs to be held in different foreign countries during the coming years. Display of samples in Government of India Showrooms and Trade Centres as well as distribution of free samples and literature among the concerned trade interests in foreign countries have also been found fruitful and hence the policy of availing of these facilities will be continued. Press publicity by releasing articles and advertisements on the Council's commodities through Trade Directories, selected magazines and newspapers published in foreign countries has been undertaken by the Council.

The Council has already sent abroad three Trade Delegations, one in 1956 to the Central European countries and the other two in 1960, to the Far East and Middle East countries to assess the marketing possibilities for cashew kernels and cashewnut shell liquid in these countries. Reports submitted by these Delegations have been published for the information of trade interests concerned. Suggestions and recommendations made by these Delegations have been implemented. During the year 1961-62 it has been decided to send two more Trade Delegations, one to Japan, Australia and New Zealand and the other to European countries.

Brand publicity for roasted & salted cashew kernels in attractive consumer tins manufactured in India will be intensified by the Council by display of them in fairs/exhibitions held in foreign countries and by distribution of them among concerned trade interests in foreign countries. It is gratifying to note that for the first time exports of roasted & salted cashew kernels in consumer tins to a few markets on a commercial scale have commenced recently.

The Council has decided to produce a documentary film in colour on cashew for screening/in public cinema houses in foreign countries.

Action has already been initiated for registration of cashew exporters with the Council under the scheme for enrolment of exporters evolved by the Government of India. This provides the basis for the evolution of a code of conduct to be observed by the exporters and could be considered as an important step towards rationalisation of export trade in cashews.

Matters like quality control of the Council's commodities, dissemination of useful information to the concerned trade interests in India and abroad, operation of incentive schemes for supply of cashew packing materials, etc., are also properly attended to by the Council.

India is the chief supplier of cashew kernels to the world markets and meets 95% of the world demand. The world demand for cashews is increasing year by year. Finding that there is no dearth of suitable climate or soil conditions for the cashew plantation in India and its great importance in the foreign trade of India as one of the leading foreign exchange earners, the Planning Commission has decided that cashew cultivation should receive still better attention during the third Five Year Plan. Accordingly targets were drawn up both for cultivation and production of raw cashewnuts during the 3rd Five Year Plan.

The question of fixation of production and export targets for cashew kernels for the 3rd Plan period is under consideration.

## Targets for the 3rd Five Year Plan

| Names of States | Additional areas to be covered in the Third Five Year Plan ('000 acres.) | Target of production of raw cashewnuts during 3rd Five Year Plan |
|---|---|---|
| 1. Andhra Pradesh | 56.5 | |
| 2. Assam | 5.0 | |
| 3. Kerala | 10.0 | |
| 4. Madhya Pradesh | 1.0 | |
| 5. Madras | 20.0 | |
| 6. Mysore | 95.0 | 106% increase. |
| 7. Orissa | 100.0 | |
| 8. West Bengal | 5.0 | |
| 9. Union Territories | 3.6 | |
| | 296.1 | |

With the successful implementation of various development programmes and with intensive export promotional measures to be undertaken by the Council, it is expected that our exports of cashew kernels will reach substantially high level bringing prosperity to the industry and Nation.

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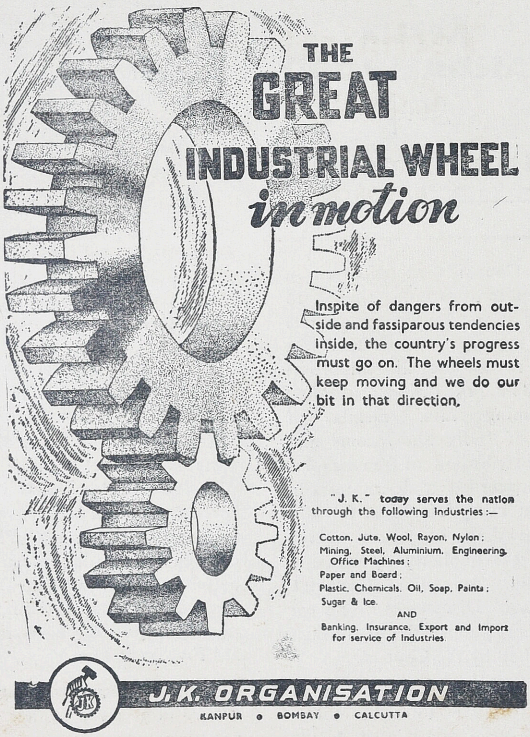

# Plant Technical College

A. SOKOLOV

The vigorous development of technology, the introduction of the latest achievements of science in all the branches of national economy, the wide-scale automation of technological processes and the utilisation of highly efficient methods in production in USSR call for higher standards of training of college students. Soviet colleges are now tackling the task of training specialists of versatile education, with a deep knowledge of corresponding branches of science and engineering. The reorganisation of the college education system, taking place now, is aimed at improving the practical and theoretical training of young specialists. With this purpose all of the country's colleges are establishing genuine contacts with life and bringing their activities closer to production. A special attention is paid to training specialists for industry and agriculture.

During enrolment in colleges, preference is given to young people with certain experience of work. Right now the network of evening and correspondence, educational establishments are being expanded all over the country. Correspondence and evening branches of colleges are being opened at major industrial and agricultural enterprises. Thereby future engineers are provided with an opportunity to combine their theoretical knowledge with experience of practical work. There are different variants of such combinations, and they all depend on the branch in which a student specialises.

One of the fine forms of combining tuition with productive work in training engineers, is the plant technical college at large enterprises, colleges which help to train higher qualification specialists. Such plant colleges are already functioning in some parts of the Soviet land. It is also considered expedient to set up colleges at industrial enterprises in which students will be able to work.

You will get an idea of a plant college if you take the case of the Likhachev Automobile Plant in Moscow. This large enterprise, in the same way as all the automobile plants in the country, was built in Soviet times. The plant produces de-luxe-class motorcars, lorries and buses. All the shops at the plant are fitted with the latest equipment.

The plant has its own big training centre, with a number of different educational establishments in it. At these, workers can, without leaving their jobs, learn any trade, cover an advanced training course, complete their secondary school education, finish a technical school, a technical college and get an engineer's diploma. All these forms of education at the plant are accessible to every worker and are free of charge.

Right now about 10,000 of the plant's workers of all ages study at these educational establishments. The organisation in charge of all the study work is the plant's department of technical training.

Starting with this academic year, the department opened one more higher technical education establishment, a plant technical college whose work will be organised on the basis of the automobile plant. The new technical college, which came into being only several months ago, so far enrolled as its first year students only 200 plant workers and employees. However, it has already attracted the attention of the young people at the plant, and now the question is being discussed of increasing next year's enrolment at this new technical college.

At present the plant technical college trains engineers in the heat-treatment of metals, in the technology of machine-building and tool-making, in foundry technology, in the technology of shaping of metals, in automobile and tractor building, and in the construction of internal combustion engines. In a talk with us Alexander Lyzo, director of the plant technical college, said that the college will fully meet the plant's demands for specialists.

The programme of the plant technical college covers a period of 5 years and 8 months. All its students are supposed to have definite experience in production and a desire to become engineers.

How is the study process organized here? Half of the students work the whole week out of which three days they go in the evening to college to hear a lecture or work in a draughting room or laboratory. While a half of the students is engaged in work, the other half studies the whole week. Consequently, there are no machines standing idle at the plant, for each one is serviced by two students. During the entire course at college the students will actually do all the major types of jobs at the plant, ranging from a worker's job to an engineer's.

When a student works he is paid a regular wage, and when he studies he gets an enlarged state stipend. A third of the students are young women, who make good progress in studies and take part in productive work at the plant.

Valentin Balabashkin came to work at the plant with seven years of secondary school behind him. He was made an apprentice of a skilled turner who helped him to master a trade. During the entire period of apprenticeship, Balabashkin was paid a wage. He could have joined the plant's technical school, training workers of the more complicated trades for the plant. But he chose to go and work straight at the plant. He wanted to complete his secondary school education, for almost all the young workers at the plant had finished secondary school. The plant has its own evening secondary school for which a special five-storey building had been erected. More than a thousand young workers study at this school without leaving their jobs. Balabashkin finished secondary school and got his school leaving certificate. After that he continued his studies in the plant's evening automotive engineering school which he graduated in 1960. In autumn last year he became a student of the plant technical college.

It should be mentioned here that the plant's technical training department has one more evening college, a branch of the Moscow Power Engineering Institute, in which hundreds of workers study without leaving their jobs, because they want to become power engineers.

The plant's technical training department is a huge educational centre in which all types of education are represented. Plant technical colleges of the same type are now functioning at the Leningrad Metal Plant, Magnitogorsk Iron and Steel Works and Rostov Plant of Agricultural Machinery.

Right now the USSR has 208 technical colleges (out of a total of 753 colleges of all types) attended by more than 900,000 students. Last year they graduated 1,17,000 engineers (while the total number of college graduates in the country amounted to 3,40,000). Soviet colleges now train engineers in the field of utilisation of atomic energy for peaceful purposes, in automation and telemetry, electronics, electrical engineering and instrument making, radio-engineering and communications, chemical engineering and other new fields.

Plant technical colleges occupy a honourable place in this college education system.

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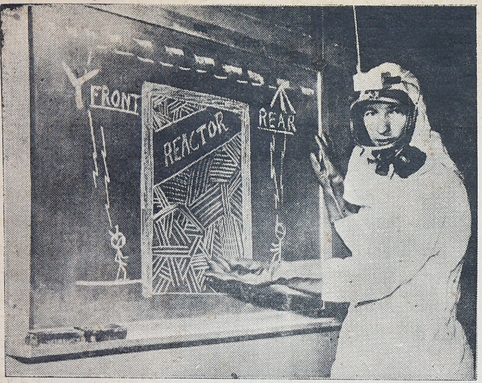
# Unusual Methods Safeguard Atomic Workers

Scientific ingenuity has played a vital role in the record of no disabling radiation injuries during the 17-year operation of the big Hanford plutonium plant in western United States. Since the early years of the so-called atomic age, Hanford scientists have pioneered in safety research. Tedious work and imagination have yielded many of the well-known techniques now used to safeguard atomic woikers around the world. Also their research has resulted in the development of some unusual, less-well-known safety techniques which are adaptations of devices, materials, and skills originally designed to serve quite different purposes.

The extreme radiation hazards inherent in the Hanford Atomic Products Operation required constant surveillance of its entire 600-square-mile site in the State of Washington. Within that area are many high-powered nuclear reactors, chemical plants for transformation of atomic elements, and facilities for storage and disposal of radioactive materials. Quite naturally, these hazards have led Hanford scientists to originate and to perfect such safeguards as concrete and lead shielding, protective clothing, remote-control, and special-handling devices. Because the entire site must be monitored constantly, from high in the air to deep underground, scientists have perfected a whole series of precise instruments for detecting and measuring radiation.

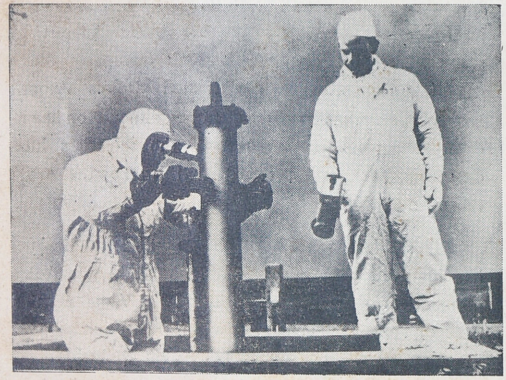
Throughout the years, Hanford's general protective measures have guarded efficiently and successfully the life and health of all its workers. However, improved techniques always are being sought by scientists of the General Electric Company which operates Hanford for the United States Atomic Energy Commission. If unusually difficult or hazardous tasks must be performed, the scientists hunt diligently for methods that will make the work easier and safer.

This effort to find the best possible techniques has involved extensive research and testing. Often a non-nuclear development is borrowed from another field of science, industry, or a profession and adapted to meet safety requirements. Some quite unusual and efficient procedures at Hanford are innovations from other fields of endeavour that have nothing to do with atomic energy.




*A Hanford technician, wearing a protective mask fitted with the receiver of a two-way radio system*

The medical profession has contributed two devices of importance. One, which the scientists call "Sneaky Peeky," is a cystoscope, used by physicians to view almost inaccessible parts of the human body. The Hanford employee who introduced this instrument, first used it to examine a reactor fitting that otherwise could not be seen from a distance. Now a cystoscope is a preferred "tool" for inspecting fuel elements, reactor apertures, and other devices in radioactive areas. The other medical instrument is a surgeon's bone saw, customarily used to remove plaster casts when broken arms or legs have mended. A scientist, who had watched the small, lightweight oscillating saw as it removed a cast from his arm, has found the device excellent for cutting aluminium-plutonium ingots. The saw cuts cleanly, producing a minimum of plutonium dust, which is a poison. The operation is performed in a transparent plastic "glove box" to confine the dust.



*A periscope, similar to the type used in submarines*

Unexpected information on earthquakes as far distant as India and Israel have been detected at Hanford through the use of a sensitive recorder originally used to determine the water level in wells. Hanford's use of the recorder is primarily a safety measure designed to provide information on water-table fluctuations. Many distant and local earth tremors have been detected, most of which were not noticeable on the earth's surface.

When underground tanks used for storage of radioactive materials must be inspected, Hanford scientists use a periscope. The intense radiation in such tanks makes viewing impossible by any other means. After considerable research, the best inspection device was found to be a periscope similar to the type used in submarines. With a periscope to guide their underground work, scientists have salvaged a large quantity of plutonium and other radioactive materials stored in an underground tank. The operation made the materials available for re-use and reduced storage requirements.

What a Hanford scientist calls "talking your way around a big reactor" is achieved by two-way radio headsets built into protective masks. The radio circuit, with an antenna above the reactor and coaxial cable extending around the outer concrete reactor shielding, enables the two reactor technicians to converse with each other and with attendants in a control room. It is used during the loading or unloading of fuel in a big production reactor, which has the rear face scaled off by a concrete wall. The radio system saves time, which is important because radiation at the rear of the reactor limits the time that a man can work in the area.

These are a few of many unusual borrowed techniques now used to safeguard Hanford workers. The numerous adaptations, together with general protective techniques, have enabled the big production plant to record annually as many as 11 million man-hours of work without a lost-time injury.

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